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Transportation of Hazardous Materials

CONGRESS OF THE UNITED STATES
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Foreword

Over 1½ billion tons of hazardous materials are transported annually in the United States. Most of these materials reach their destinations safely because it is in society's and industry's best interests to have them do so. We Americans take for granted the convenience of our transportation system and the amenities of modern life that the petroleum, chemical, and nuclear industries help make possible. Sometimes, however, an accident occurs, and a hazardous material is released, causing damage to the public and the environment. The occasional serious accident is both frightening and worrisome, while a disaster, such as the thousands of deaths and injuries in Bhopal, India, and the enormous release of radioactivity at Chernobyl, raises public apprehensions dramatically. Indeed, few activities with such statistically low risks as the transportation of hazardous materials arouse such intense public concern.

The Hazardous Materials Transportation Act, passed in 1975, is the primary Federal law governing this transportation. Largely unchanged in the past dozen years, the Act will be scrutinized carefully by Congress in the near future as it comes due for reauthorization. To determine whether major safety problems exist in the transportation of hazardous materials that should be addressed through legislation, and whether appropriate technologies exist that could improve this essential portion of our Nation's commerce, the Senate Committee on Science, Commerce, and Transportation requested the Office of Technology Assessment to undertake this study. Subsequently, the House Committee on Public Works; the Subcommittee on Commerce, Transportation, and Tourism of the House Committee on Energy and Commerce; and the Subcommittee on Government Activities and Transportation of the House Committee on Government Operations endorsed the study. OTA's report on *Transportation of Hazardous Materials* includes a comprehensive assessment of the regulations, information systems, container safety, and training for emergency response and enforcement for consideration by Congress as it deliberates on reauthorization of the Hazardous Materials Transportation Act.

The advisory panel, workshop participants, and contributors for this study played key roles in developing the major issues and contributed a broad and invaluable range of perspectives. OTA thanks them for their commitment of time and energy. Their participation does not necessarily represent endorsement of the contents of the report, for which OTA bears sole responsibility.

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its content.

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Chapter 1

Executive Summary

Photo credit: Andy Witherspoon

Port of Long Beach

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Chapter 1

Executive Summary

Hazardous materials are transported safely every hour of every day. Yet few activities with such statistically low risks arouse such intense public concern. Houston citizens did not remain calm when a speeding truck carrying an intermodal tank of highly flammable methyl methacrylate hit an exit ramp guardrail. The driver was killed. The tank broke open, its contents ignited, and the resulting inferno destroyed part of the freeway and dropped burning debris on the street below. Fortunately, no one else was hurt, and the Houston Fire Department already had a hazardous materials response team with the knowledge and equipment to handle the accident.[1] Denver residents were similarly stunned when a truckload of Navy torpedoes overturned one Sunday morning on a city freeway exit loop. No one was injured, but hours passed before experienced Federal assistance arrived. Worried State and local officials did not know whether the scattered weapons needed to be defused before cleanup could begin.

Although by now most Americans are aware that hazardous materials can wreak enormous health and environmental damage, we continue to take for granted both transportation and the amenities of modern life brought to us by the petroleum, nuclear, and chemical industries. Consequently, spectacular accidents, while relatively infrequent, remind us of the harm that can be done and underscore a demand that something be done to keep them from happening—or at least help us be prepared to handle them safely.

Over 1.5 billion tons of hazardous materials were transported by land, sea, and air in the United States in 1982.* (For a tonnage breakdown by mode, see table 1-1.) Truck transport, by a fleet of 467,000 trucks, accounts for more than half of all hazardous materials shipments, or about 927 million tons per year. Because this means a great many truck shipments, hazardous materials emergency response training is especially important for State and local public safety officers who are usually the first called to an accident.

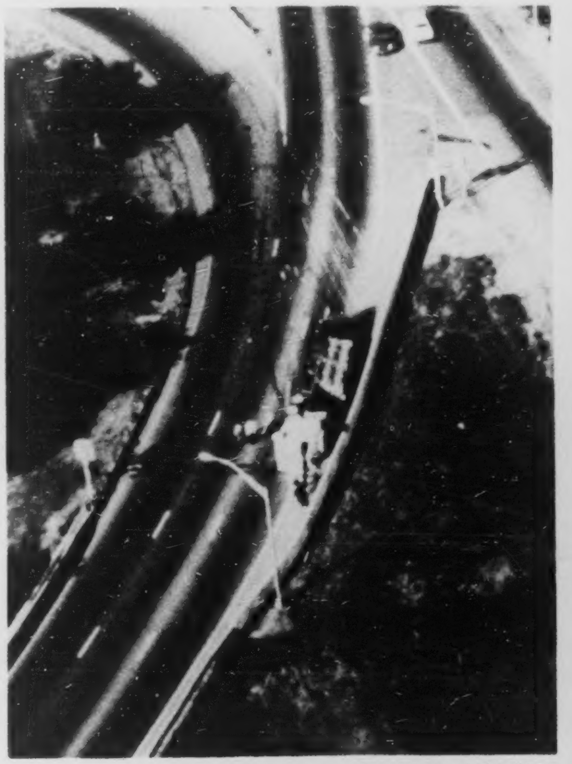

Photo credit: National Transportation Safety Board

Tractor-trailer carrying torpedoes overturned on an offramp of a Denver freeway.

The types of vehicles carrying hazardous materials on the Nation's highways range from cargo tank trucks to conventional tractor-trailers and flatbeds that carry large portable tank containers or nonbulk packages, such as cylinders, drums, and other small containers. Rail shipments are usually bulk commodities such as liquid or gaseous chemicals and fuels, carried in tank cars. Most hazardous materials transported by water are moved in bulk containers, such as tank ships or barges, while air shipments are typically small packages, often high-value or time-critical material.

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[1] Jack Douglas and Dan Grothaus, "Trucker Dies in Fiery Crash," *The Houston Post*, July 31, 1985, p. 1A.

*Based on OTA calculations from data supplied by the U.S. Bureau of the Census and other sources. See ch. 2 of this report. This does not include pipeline transportation, which would more than double the annual total.

Table 1-1.—Estimated Transportation of Hazardous Materials in the United States, by Mode in 1982

Mode	Number of vehicles/vessels used for hazardous materials	Tons transported	Ton-miles
Truck	337,000 dry freight or flat bed 130,000 cargo tanks	927 million	93.6 billion
Rail	115,600 tank cars	73 million	53 billion[a]
Waterborne	4,909 tanker barges	549 million	636.5 billion
Air	3,772 commercial planes	285 thousand	459 million
Total		1.5 billion	784 billion

[a] 1983 data; 1982 data had too many errors to allow calculations.

SOURCE: Office of Technology Assessment calculations based on Federal data augmented by other resources.

People are most concerned about those risks that are involuntary, uncontrolled, unfamiliar, immediate, manmade, and catastrophic.[2] Hazardous materials transportation possesses many and sometimes all of these attributes. Risk assessments can help to address two fundamental questions, one quantitative and objective and one qualitative and subjective:

- What is the level of risk?
- What levels of risk are acceptable to the parties concerned?

The first question is relatively readily addressed with adequate data and proper methodology, although two essential components must be documented—probability and consequence. The second question, however, involves numerous judgments and often a great deal of discussion and negotiation, especially when large numbers of people and several governmental jurisdictions are involved. It is the balance between the answers to these two questions that this report is all about. The Office of Technology Assessment (OTA) can address primarily the first question; decisions about the second fall in the province of public officials at every level of government and citizens across the country.

Public concerns expressed to Congress are rooted in the facts that the level of understanding about hazardous materials transportation in or near a jurisdiction is generally low, and that the technical experts, both industry and Federal regulators, are not trusted to provide complete information about the level of risk or to ensure safety. State and local governments, finding that Federal regulations have not prevented accidents in their cities, have passed legislation requiring permits and fees or restricting hours of travel for hazardous materials, in an effort to control what is perceived to be a substantial public risk. In addition, some large jurisdictions have formed special fire department hazardous materials teams to respond to accidents or spills. Some State and local government and industry groups have united to form a Hazardous Materials Coalition to lobby for greater Federal support for training.

Public apprehensions notwithstanding, most hazardous materials are transported safely to their destinations because:

- Industry—manufacturers, shippers, and carriers—is, for the most part, aware of the dangers of the products and its liability for the personal, property, and environmental damage and expense that an accident could cause and takes appropriate precautions.
- Hazardous materials transportation is heavily regulated by several governmental bodies.

The basic regulatory structure has been developed, largely by industry, over the last 100 years, and mostly before public awareness of the dangers of toxic substances and understanding of the complex measures necessary to protect public health and the environment reached their present levels. There have been no far-reaching regulatory reforms and no strategic changes to help the system cope with late 20th century technologies and public awareness. For instance, changes in container regulations have addressed individual container designs and specific situations, rather than recognizing that the interaction between container and carrying vehicle has an enormous impact on safety. Although long-established Federal regulations and industry care have helped to maintain the public safety, it is time to modernize our approach and address some of the very real shortcomings in the current system.

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[2] N.C. Rasmussen, "The Application of Probabilistic Risk Assessment Techniques to Energy Technologies," *Annual Review of Energy*, vol. 6, 1981, pp. 123-138.

More often than not it is people problems—inadequately trained personnel, poor coordination and communication—or lack of information and advance planning, rather than technological shortcomings, that cause accidents, injuries, or environmental damage.* Yet, the roles of the many Federal agencies charged with meeting the complex problems are poorly coordinated and defined. Federal programs that provide technical assistance to State and local governments for emergency response enforcement, accident prevention, and planning activities are uncoordinated, and many find them insufficient and underfunded as well.

The Nation's 39,000 local governments know that their public safety officers will be first on the accident scene and are demanding assistance in being prepared.[3] Differing Federal, State, and local regulations mean that a highway transporter may need to pay four or five different registration fees and have an equal number of permits to complete one shipment through several States.[4] State and local officials find it difficult and sometimes impossible to acquire the basic information on hazardous materials production and transportation that they need to plan and prepare for emergencies.[5] Data available from the Federal Government is disparate, incomplete, and not helpful for these purposes. Moreover, the regulatory process for containers works against innovation in design, thus making the United States less competitive in the international market. In short, the system is burdensome to industry without providing adequately for public health and safety.

The cumbersome system has endured in part because Federal records imply that hazardous materials accident rates are low. However, OTA finds that Federal accident records suffer from significant underreporting and do not provide an accurate assessment of the level of safety in the transportation of hazardous materials. In any case, arguments over statistics are immaterial to the public safety person first at the scene of the accident. He is likely to be one of the Nation's 1 million largely untrained volunteer firefighters and may be confronted with a placarded, derailed railroad tank car spewing a mysterious cloud that burns his eyes.* Chances are his basic training has included suiting up, moving in, and spraying water or foam on such a car. He probably has not heard that the simplest equipment for dealing with a hazardous materials accident includes tennis shoes and binoculars—tennis shoes to run away and binoculars to read the hazardous materials placard from a distance before calling for expert help. He also will not know that State enforcement records show that between 25 and 50 percent of trucks are incorrectly placarded,[6] so if he must respond to a truck accident, accurate identification of the substance involved may be difficult and time-consuming.

Where does the local official look for help in training emergency response people? He could turn to one of four or five agencies in the U.S. Department of Transportation (DOT), the Federal Emergency Management Agency (FEMA), or the U.S. Environmental Protection Agency (EPA). However, the Federal Government offers no guidance about who offers what kind of training or how much it will cost. At the State level, he might seek assistance from the Departments of Environmental Health, Transportation, Public Works, or any of several others, or from the State Fire Marshal's Office. Even if he should succeed in discovering the right group, no funding may be available, and no national training standards have been developed to help choose the appropriate course.

While no national framework for ensuring training exists, all levels of government have a potent tool for dealing with problems/regulations. The massive regulatory code governing the transportation of all hazardous materials except bulk water transport is Title 49 of the *Code of Federal Regulations* (known as 49 CFR). More than 30,000 hazardous materials are subject to these regulations. However, although DOT is authorized to regulate all hazardous materials shipments, and does so for rail, air, and water, it has chosen to exclude intrastate highway transport specifically from regulatory coverage under 49 CFR.[7] In addition, individual States and regional and local governments enact laws, set regulations, and undertake enforcement activities—primarily for the highway mode—that overlap or vary from those set by the Federal Government and by neighboring jurisdictions. The result is a complicated and constantly changing set of controls. Even those Federal officials who write or work directly with the regulations or the memoranda of understanding governing the process can explain only the Federal roles clearly. Hazardous materials enforcement officers and transportation industries—manufacturers, shippers, and carriers—find this welter of regulations inefficient, confusing, and difficult to comply with and enforce.

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*Sixty-two percent of reported hazardous materials spills are caused by human error. See ch. 2 of this report.

[3] Paula N. Alford, National Association of Towns and Townships, "A National Hazardous Materials Emergency Response Fund," unpublished background paper, December 1985, p. 4.

[4] U.S. Congress, Office of Technology Assessment "Transcript of Proceedings—Workshop on State and Local Activities in the Transportation of Hazardous Materials," unpublished typescript, May 30, 1985.

[5] Ibid.

*Emergency response to a railroad accident often involves an industry/railroad response team as well as public response personnel.

[6] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, March 1986), p. 63.

Moreover, data and information about shipments are so poor and difficult to acquire that State and local regulations are often developed with little or no understanding of the magnitude or nature of the problems to be controlled. For example, gasoline is by far the most frequently transported hazardous material, accounting for almost half of all hazardous materials transported over the highways. Furthermore, almost all gasoline truck trips are local deliveries, making the risk of exposure to the public higher for gasoline than for any other substance. Not surprisingly, therefore, gasoline transport is responsible for more injuries and dollar damages than all other hazardous materials together. Yet State and local transportation restrictions are usually aimed at shipments of hazardous wastes or radioactive materials, which together account for less than 3 percent of all hazardous materials shipments and are already heavily regulated.

This report discusses transportation of all hazardous materials—commodities, radioactive materials including spent nuclear fuel, and hazardous wastes —that travel by truck, rail, water, or air. Pipeline transport is not considered, as its regulation is entirely different from that of vehicles or vessels. One thing is clear—regardless of whether gasoline, anhydrous ammonia, or high-level nuclear waste is being transported, everyone responsible wants to ensure public safety and prevent environmental damage. Disagreements arise primarily over how best to accomplish these aims and how to distribute the costs of the necessary safeguards equitably. OTA has identified four paramount policy issue areas for congressional consideration:

- **Training.**—Development of a national strategy to provide training for State and local emergency response and enforcement personnel. Training guidelines, adequate funding, and providing comprehensive information on existing resources are key components.
- **Federal/State Regulations.**—Greater consistency in Federal, State, and local regulations and enforcement, including extending Federal reporting requirements for hazardous materials releases to intrastate highway transportation. Coordination and cooperation between all levels of government in developing consistent regulations will reduce conflicts and duplication of effort.
- **Public Information.**—Increased availability of information about the transportation of hazardous materials, including spent nuclear fuel. More coordinated Federal data-collection activities would support regulatory decisions and improve public information programs. National guidelines for community right-to-know legislation and Federal assistance for State and local information gathering could be helpful.
- **Containers.**—Better Federal coordination in setting container regulations, including those for spent nuclear fuel. Two areas warrant specific attention: 1) technical requirements, such as changes in gasoline cargo tankers and design tests for spent fuel casks; and 2) operational and procedural practices, such as quality control and industry training.

Underlying these four issues is the lack of clear definition of Federal and State roles and of effective program coordination to make activities more accessible and cost-effective. The basis for many programs to address these issues already exists, but lack of communication and integration between and among different levels of government diminishes their effectiveness.

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[7] 49 CFR Part 171.1.

FEDERAL GOVERNMENT RESPONSIBILITIES

Authority for issuing Federal regulations and developing and implementing programs rests with many different entities. The Federal Government has four roles related to hazardous materials transportation: regulation, enforcement, emergency response, and data collection and analysis. DOT is the lead agency for establishing and enforcing regulations regarding safe transportation of hazardous materials. The DOT Research and Special Programs Administration (RSPA) has authority to issue regulations on many aspects of hazardous materials containers, except for bulk marine shipments, which are regulated by the U.S. Coast Guard. RSPA shares inspection and enforcement activities with the modal administrations, the Federal Highway Administration, the Federal Railroad Administration (FRA), the Federal Aviation Administration, the National Highway Traffic Safety Administration, and the Coast Guard, which also have authority over the vehicles or vessels themselves. RSPA is responsible for identification of hazardous materials as well as:

- regulation of hazardous materials containers, handling, and shipments;
- development of container standards and testing procedures;
- inspection and enforcement for multimodal shippers and container manufacturers; and
- data collection.

Another group of agencies—the Nuclear Regulatory Commission (NRC), EPA, and the Occupational Safety and Health Administration (OSHA)—regulates other aspects of hazardous materials transportation. NRC has jurisdiction over high-level radioactive substances in the civil sector, EPA has responsibilities for chemicals and hazardous nonnuclear wastes, and OSHA is concerned with worker safety. These agencies also undertake training activities and provide technical support for State and local governments.

Three additional agencies have nonregulatory functions related to the transportation of hazardous materials. The U.S. Department of Energy (DOE) will be responsible for high-level nuclear waste movement, storage, and disposal under the Nuclear Waste Policy Act of 1982. The U.S. Department of Defense (DOD) transports many hazardous materials for military purposes. FEMA is responsible for coordinating Federal assistance, planning, and training activities for all types of emergency response with State and local governments. See table 1-2 for a summary of Federal agency activities.

The data-collection function is similarly spread among Federal agencies, most of which record accidents and spills and monitor compliance and, sometimes, carrier performance. RSPA is the principal agency collecting data on releases of hazardous materials during transportation, but every other Federal entity keeps records pertaining to its area of interest. General commodity flow information is collected by the Bureau of the Census, making possible estimates of hazardous materials flows, and RSPA has made good use of some of the census data for a truck flow study. However, budget constraints at the Bureau of the Census have restricted its data collection considerably, and no additional analysis or exchange of hazardous materials transportation flow information from other agencies is evident.[8] This type of data is essential as a denominator for even crude analysis of accident rates, and its lack is a deficiency in RSPA's planning and regulatory activities.

Perhaps more serious is the lack of interagency coordination for recordkeeping on accidents and releases of hazardous materials. For its own records, RSPA depends primarily on reports filed by mail on its Form 5800.1, which has numerous deficiencies in itself. The databases kept by other DOT modal administrations and the National Transportation Safety Board (NTSB) contain numerous accidents OTA has identified as being related to hazardous materials that are missing from the official RSPA accident file, the Hazardous Materials Information System (HMIS). Although the potential exists for much better data exchange and use, HMIS reporting requirements are so narrow, and data collection and analysis are so inadequate that RSPA

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[8] However, a good deal of analysis related to risk items, such as transporting outdated chemical weapons over different routes, for example, has been carried out at Oak Ridge National Laboratory. S.A. Carnes, et al., Oak Ridge National Laboratory, *Preliminary Assessment of the Health and Environmental Impacts of Transporting M55 Rockets From Lexington-Blue Grass Depot Activity, Anniston Army Depot, and Umatilla Depot Activity to Alternative Disposal Facilities* (Washington, DC: U.S. Department of Energy, November 1985).

Table 1-2.—Federal Activities in Hazardous Materials Transportation

	Regulation of:									
	Hazardous materials†	Containers	Vehicles and vessels	Operators	Planning	Recordkeeping	Inspection	Enforcement	Training	Emergency response
DOT:										
RSPA	X	X			X	X	X	X	X	
FHWA		X[a]	X[b]	X	X	X	X	X	X	
FRA		X[a]	X		X	X	X	X	X	
FAA		X[a]	X		X	X	X	X	X	
USCG	X	X[a]	X	X	X	X	X	X	X	X
FEMA					X				X	X
EPA	X				X	X	X	X	X	X[c]
NRC	X	X			X	X	X	X	X	X[d]
DOE	X[e]	X		X	X	X	X	X	X	X[d]
DOD	X[e]			X	X	X	X	X	X	X

KEY: DOT—Department of Transportation; RSPA—Research and Special Programs Administration; FHWA—Federal Highway Administration; FRA—Federal Railroad Administration; FAA—Federal Aviation Administration; USCG—United States Coast Guard; FEMA—Federal Emergency Management Agency; EPA—Environmental Protection Agency; NRC—Nuclear Regulatory Commission; DOE—Department of Energy; DOD—Department of Defense.

†This category includes hazardous substances, hazardous wastes and radioactive materials, and the tools for communication of those hazards such as shipping papers, placarding, and marking.

[a] Package/container design.

[b] In addition, National Highway Transportation Safety Administration issues requirements for new vehicles.

[c] EPA responds to accidents involving the release of products regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and oil spills in coastal and ocean water.

[d] Depends on the type of radioactive material, severity of the accident, and the adequacy of State and local response programs.

[e] In cases of national security, DOD and DOE are not required to comply with DOT regulations provided they follow standards affording equal protection.

SOURCE: Office of Technology Assessment.

has insufficient information to set timely priorities for regulatory actions. Rulemakings are initiated either by petition from industry or an interested party, or are forced on DOT by widespread public concern, often focused through NTSB or Congress. This kind of reactive rulemaking does not measure up to today's needs. Often research or data analysis could have supported the need for change earlier, or the need was documented some time ago—for example, the reclassification of methyl isocyanate from flammable to toxic inhalant—and no action was taken for years.*

The division of responsibilities among multiple Federal agencies and DOT entities developed on the theory that hazardous wastes, radioactive materials, emergency response training, modal safety concerns, and multimodal hazardous materials questions should be addressed by those with appropriate expertise. The Memoranda of Understanding that have been signed between DOT and NRC, EPA, and DOE focus on delegating responsibility under specific laws. Aside from these agreements, there are no formal mechanisms for interagency regulatory coordination, and no attempt at developing a uniform basis for rulemaking or establishing criteria to set rules and standards has been made. Issues that require the coordinated attention of more than one Federal agency, or Federal and State or industry coordination, often take years to resolve, and no effective effort has been made to improve the situation. The one official Federal coordinating group that does exist, the National Response Team, considers primarily emergency preparedness and response activities and has in the past concentrated on managing Federal response. Until very recently, it has done little to define agency roles, diminish the public's confusion, or meet the crying need for State and local emergency response training with vigorous Federal action.

Complicating matters further, a number of international regulatory bodies have developed recommendations and standards affecting all modes of transport. Federal regulations are being revised to conform with these international codes, particularly those for the air and water modes. Recommendations for objective performance standards for nonbulk packaging issued by the United Nations Committee of Experts on the Transport of Dangerous Goods have been adopted by many countries. However, DOT has not yet adopted performance standards for nonbulk packagings, even though a proposal has been under consideration since 1982.

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*This reclassification was suggested at the Williamsburg Conference sponsored by the National Academy of Sciences in 1980 and was the subject of the U.S. Department of Transportation (DOT) activity in the early 1980s. The effort was dropped, until the National Transportation Safety Board and congressional concern highlighted the issue after the tragic deaths and injuries in Bhopal, India. The subsequent DOT rulemaking was completed in under a year.

The absence of effective Federal program coordination hampers State and local access to available planning, information, and financial resources. Moreover, authority for matters pertaining to hazardous materials rests with a similar variety of agencies in most States. Frequently, responsibility is equally fragmented at the local level. In view of the numbers of agencies and levels of government involved, it is not surprising that hazardous materials transportation safety and training programs and activities, and even some regulations, are uncoordinated, preventing efficient use of already scarce resources.

FINDINGS AND POLICY OPTIONS

Hazardous materials transportation safety is not a local, State, or even national problem only; it has global implications. It is decidedly not a partisan issue, and there is little disagreement on the most important problems. However, finding solutions acceptable to a sufficiently broad spectrum of interested parties to achieve the consensus required for legislation is not easy.

Policy options are clustered around the major issues identified earlier: training for emergency response and enforcement activities, regulatory consistency and reform, data collection and information needs, containers, and cutting across these, Federal programmatic coordination.

Emergency Response Training

Emergency response to hazardous materials incidents is unlike traditional firefighting in that response personnel must identify the specific chemical hazards facing them before approaching an accident or attempting a rescue mission.[9] An inappropriate response to an accident involving unfamiliar chemical products can endanger individuals, the surrounding community, and the environment. Local fire or police department personnel are usually the first to respond to a hazardous materials accident during transportation, and even in a plant, hence their training is of primary importance. Of the approximately 2 million people in the emergency response network, OTA estimates that a maximum of 25 percent have received adequate training to meet a hazardous materials emergency. Training programs are offered primarily by the States or private organizations, and by the Federal Government. Most local response forces have insufficient financial resources to take advantage of available training. The spectrum of local hazardous materials training ranges from well organized and funded hazardous materials courses offered by highly trained individuals to little or nothing.[10]

Of the approximately 1.2 million firefighters in the Nation, 85 percent are volunteers and 15 percent are paid employees of municipal, county, or local governments.[11] However, of the roughly 1,000 persons participating annually in the resident training program in hazardous materials emergency response offered by FEMA at its Emmitsburg, Maryland, training center, 85 percent are paid personnel and 15 percent are volunteer.[12]

According to the National Association of Chiefs of Police, there are between 450,000 and 500,000 local sheriffs and police personnel employed by State and local governments;[13] who are also often called on to provide emergency response. Over 450 training courses in hazardous materials emergency response, planning, and enforcement are available in the Nation, according to a study undertaken at congressional direction by DOT and FEMA in 1985.[14] Costs for these courses are impossible to isolate, since only aggregate figures are available, but the total dollars spent for training in both emergency response and enforcement, as reported in the Federal study, total $36 million for the 5-year period of 1980-84.[15] While the study did not capture the universe of State and local training, OTA's own research implies that the bulk of the dollars spent have been reported. Moreover, the Federal dollars are of the greatest interest.

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[9] Charles Wright, lecture at Hazardous Materials First Responders Course presented by Union Pacific Railroad and U.S. Environmental Protection Agency Region VII, April 1985.

[10] Association of Bay Area Governments, *National Directory of Hazardous Materials Training Courses* (San Francisco, CA: March 1985), p. 8. Data supplied by the International Association of Fire Chiefs to OTA.

[11] Joseph Donovan, National Fire Academy, Federal Emergency Management Agency, Emmitsburg, MD, personal communication, 1985.

[12] James Covington, Hazardous Materials Instructor, Federal Emergency Management Agency, Emmitsburg, MD, personal communication, 1985.

[13] Gerald Arenberg, Executive Director, National Association of Chiefs of Police, personal communication, 1985.

[14] U.S. Department of Transportation and Federal Emergency Management Agency, "Report to Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, January 1986.

The majority of Federal expenditures have been for the longer term, advanced level response training courses of the type offered by FEMA at Emmitsburg. Such courses are appropriate for personnel who will be part of a hazardous materials emergency response team in an area with an identified high-hazard potential, although these represent a relatively small percentage of the Nation's firefighters. The volunteer firefighters and emergency response forces from small urban and rural areas usually have no hazardous materials training at all. Participants in an April 1985 FEMA-sponsored workshop of national, State, and local experts agreed that emergency response personnel in these areas are most in need of training.[16] Moreover, according to a FEMA disaster planning survey,[17] hazardous materials emergencies comprised 4 of the top 10 emergencies considered likely to occur in a community.

OTA concludes that a national strategy to provide an appropriate level of hazardous materials emergency response training, either basic or advanced, to local personnel is an urgent priority. OTA estimates that approximately 1.5 million emergency response personnel need additional hazardous materials training, with the vast majority needing basic first response training. Maintaining the level of expertise through refresher courses for those already trained is also important. Additional expenditures necessary to train 10 to 15 percent of those needing training total $15 to $20 million annually, OTA estimates. This sum could come from a variety of public and private sources, and assumes maximum cooperation between Federal, State, and private groups now providing training and coordinated use of existing training resources, including those of industry. (See table 1-3.) The Federal role in developing a comprehensive national training strategy, building on existing training resources, could include assistance in preparing training guidelines, helping to ensure adequate funding, and developing a training information clearinghouse.

The problem is not that courses are unavailable, but rather that those who need them are unable to take advantage of them. The reasons are institutional as well as financial. Better organization and utilization of existing resources could improve training delivery considerably. Existing Federal hazardous materials emergency response training and training support programs in FEMA, EPA, the Coast Guard (DOT), NRC, and DOE need to be coordinated and made complementary. They also could be better utilized to meet State and local training needs as well as those of Federal forces.

Table 1-3.—Calculations for Costs of Hazardous Materials Emergency Response Training for First Responders[a]

Target audience:
First responders—firefighters, police, hospital emergency room staff, and ambulance drivers.
Size of target audience:
1.5 million (approximate)
Nature of training:
Basic training covering identification of hazardous materials, the importance of self protection, protection of the public and environment, and the notification of authorities.
Duration of training:
Modular training geared to appropriate target audiences would be developed and taught by trained instructors. Must provide opportunities for role playing and group problem solving and acquaint response personnel with the unique dangers of hazardous materials response.
Key cost components:
Course development, handout materials/workbooks, instructional services, training personnel, travel, and equipment.
Estimated average cost per trainee:
$100[b]
Estimated trainee completions per year:
150,000 to 225,000
Required annual funding total:
$15 to $22.5 million

[a] This type of training emphasizes the differences between hazardous materials response and firefighting. Training covers the dangers inherent in hazardous materials accidents, how to identify hazardous commodities, appropriate responses, and the application and use of protective equipment. Basic training is not designed to cover advanced hazardous materials response techniques or cleanup procedures.

[b] OTA estimates based on tuition for existing courses and interviews with officials and course instructors. Charges vary widely—one large and successful 2-day program is free, whereas another more comprehensive 3-day course charges tuition of $450.

SOURCE: Office of Technology Assessment.

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[15] Ibid., p. ix.

[16] Robert S. Wilkerson, Chief, Technological Hazards Division, Federal Emergency Management Agency, personal communication, June 1985.

[17] Federal Emergency Management Agency, *Hazard Identification, Capability, Assessment, and Multi-Year Development Plan for Local Governments*, CPG 1-35 (Washington, DC: January 1985).

However, choosing the right agency to coordinate Federal emergency response programs and administer any special funding program is problematic. Institutionally, that agency is FEMA. Yet while there is widespread agreement about the need for a strong, central Federal leadership role in emergency response training, there is equally widespread doubt about whether FEMA can provide that leadership. Moreover, States find FEMA's grant requirements so restrictive that they cannot meet their State's program needs and still qualify for FEMA grants. It is only fair to say that some of FEMA's administrative difficulties stem from the statutory restrictions of the Civil Defense Act of 1950, FEMA's primary source of funds for hazardous materials activities.* However, DOT, EPA, DOE, and NRC have narrower areas of emergency response expertise and their responsibilities for training are focused primarily on Federal response.

One congressional option is to charge the National Response Team with responsibility for coordinating hazardous materials emergency response training and developing guidelines for courses and levels of training using a consensus process. Congress might wish to designate DOT, EPA, or FEMA, as members of the National Response Team with direct responsibility for training, as lead agency for developing a direct contract program with States for funding training. Funds distributed to States for hazardous materials transportation emergency response training might carry a stipulation that some funds be passed through to local jurisdictions.

Over the past decade, hazardous materials manufacturers have taken steps to address safety concerns. Industry's involvement in hazardous materials emergency response ranges from technical assistance to specialized response teams. Many large petrochemical and chemical manufacturers train and maintain company emergency response teams for both their fixed facilities and transportation accidents. The best known effort is the Chemical Transportation Emergency Center (CHEMTREC), established in 1970 by the Chemical Manufacturers Association (CMA). CHEMTREC staff provide chemical information by telephone for use in onsite decisionmaking and notify manufacturers of accidents involving their products. CMA has also developed the Community Awareness and Emergency Response Program, which encourages industry and community cooperation in the development of emergency response plans. The Channel industries, the Pesticide Safety Team Network, and Chlorep are other examples of cooperative emergency response capabilities provided by industry.

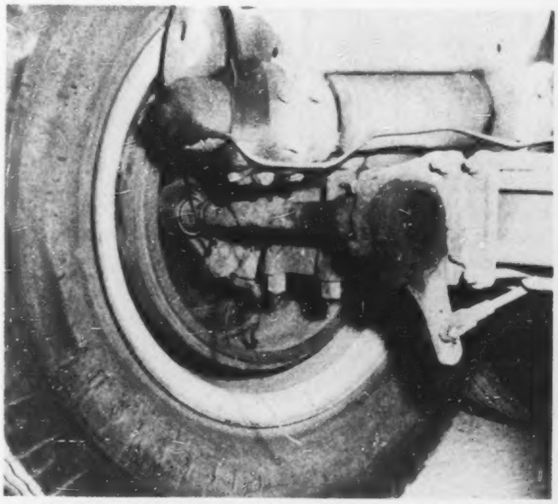

Photo credit: Research and Special Programs Administration, DOT

An accident waiting to happen—inadequate brake repair discovered during truck inspection.

These specialized information and emergency response units were formed by industries to respond to accidents involving their products. With their specialized resources, detailed knowledge of hazardous materials, and extensive product information, industries can provide a logical adjunct to public safety capabilities for fixed facility and hazardous materials transportation emergency response. Furthermore, some industry training resources have been made available to meet State and local needs. A public-private agency cooperative training program has been established by EPA and the Union Pacific Railroad in EPA Region VII. They offer a 2-day training course for hazardous materials identification, free of charge to multidisciplinary groups with emergency response duties.

The most cost-effective training programs are those that use train-the-trainer techniques. These courses also serve as conduits for programs developed according to nationally accepted guidelines.

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*The Emergency Management Assistance Program is the vehicle through which States receive funds for activities related to hazardous materials.

Congress might consider giving funding priority to States whose training officials participate in Federal hazardous materials training programs and subsequently develop State training networks using train-the-trainer courses to improve delivery of training to local emergency response personnel.

OTA concludes that development of national hazardous materials emergency response training guidelines covering course offerings and levels of training is urgently needed by State and local officials. Guidelines for training in equipment use and maintenance would be useful as well. Activities begun this year by the National Response Team and the National Fire Protection Association to develop guidelines are commendable. Broad-based participation of producers, shippers, and emergency response personnel in developing the guidelines is important. At the Federal level, this would mean that DOT, FEMA, EPA, and probably NRC and DOE need to cooperate and reach agreement, as well as firefighters and other safety groups.

Finally, OTA finds that developing a national clearinghouse to make existing information on hazardous materials training programs and resources available to State and local personnel, both in hard copy and online, would provide an extremely useful service to emergency response forces. The 1985 DOT/FEMA study provides basic information already in computerized form for such a service. Several successful programs exist as models in other areas, most notably, a DOT-sponsored microcomputer information exchange administered through a university.[18]

Training for Enforcement

Consistent, strong enforcement of hazardous materials regulations is a major accident prevention tool. **State enforcement activities have become increasingly important as Federal inspection and enforcement manpower has been reduced.** The number of DOT vessel and vehicle inspections declined in 1984 for every mode except rail, where special congressional appropriations have been made. The DOT man-years devoted to hazardous materials inspections fell from 237 in 1979 to 111 in 1984,* with the most notable decline in the Coast Guard. Appropriations to provide additional support for Federal enforcement have not been forthcoming. However, a DOT-State contract program, the multimodal State Hazardous Materials Enforcement Development (SHMED) program, helped 25 States develop hazardous materials enforcement expertise and training capabilities. Developed by RSPA through the DOT Transportation Safety Institute, SHMED used home study materials and train-the-trainer techniques to reach large numbers of enforcement and industry personnel in participating States. The program has been both effective and inexpensive; overall expenditures through 1986, when the program expires, will have amounted to just over $3 million.

However, after the SHMED program is phased out, DOT financial support for State hazardous materials enforcement development will continue for motor vehicles only, bolstered by the Motor Carrier Safety Assistance Program (MCSAP), administered by the Bureau of Motor Carrier Safety (BMCS) in the Federal Highway Administration. The MCSAP grant program is designed to improve State capabilities to enforce motor carrier safety regulations, to conduct commercial vehicle inspections both in terminals and along roadsides, and to collect safety data. MCSAP funds may be applied to hazardous materials enforcement activities at the discretion of the State. MCSAP expenditures for 1985 were $14.2 million, and the Secretary of Transportation requested the full funding level of $50 million for MCSAP funds for 1987.

Hazardous materials flow and accident data, poor as they are, show clearly that truck transport has the greatest risk of accidents, and Federal and State inspectors in 1985 pulled out of service for violations an all time high of about 40 percent of inspected trucks. MCSAP gives priority to general motor carrier safety programs, justifiably in light of these facts. However, concerns that hazardous materials enforcement activities are being slighted—especially for the rail, water, and air modes—have been raised by many State, local, and industry officials.* **OTA finds that Federal programs developed through the Transportation Safety Institute for enforcement training have provided effective**

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[18] Ron Jensen-Fisher, Project Manager, Urban Mass Transportation Administration, Transit Industry Microcomputer Exchange, personal communication, March 1986.

*Complete 1985 data were not available in time for OTA's report.

*This has been a pervasive theme throughout OTA's information gathering.

Photo credit: Shell Oil Co.

This petroleum industry training course shows response personnel how to prepare an overturned tank truck for offloading of the product before the truck is righted.

support for State enforcement training needs. In addition, OTA concludes that MCSAP provides essential funding and support for State motor vehicle enforcement and training programs, but that Federal enforcement programs are not adequate for the other modes. If Federal inspections continue to decline, support for development of alternative hazardous materials inspection and enforcement programs for water, rail, and air is needed.

Responsibility for inspections of container manufacturing facilities might best be left with the Federal inspection forces. The specialized expertise required and the relatively small number of inspections would make development costly for State capabilities to check compliance with container design requirements. Adequate levels of inspection and enforcement, however, even for these targets, would require increased Federal forces. In 1984, for instance, only 144 of the more than 7,000 container manufacturers were inspected by RSPA and FRA, and only 5,220 of the estimated 100,000 shipping facilities were inspected.[19] **Congress might increase DOT's enforcement budget particularly in the areas of water, rail, and air hazardous materials inspections, which are not covered by State enforcement and inspection programs. OTA concludes that Federal inspection forces, which have been halved over the past 5 years while shipments of hazardous materials have been increasing,[20] are now insufficient to ensure adequate inspection levels.** (See table 1-4.)

Financing Emergency Response and Enforcement Training

OTA finds that the approximately $7.2 million* spent annually for emergency response and enforcement training is insufficient to provide adequate hazardous materials training. While the SHMED and MCSAP programs have provided basic Federal support for enforcement training, emergency response training has not received similar Federal attention. The management of the SHMED

Table 1-4.—Hazardous Materials Transportation Inspectors

	1979	1980	1981	1982	1983	1984
Total work-years:						
United States Coast Guard	115.5	115.5	155.8	50.0	40.0	12.0
Federal Aviation Administration	36.9	19.0	17.8	8.2	14.1	15.0
Federal Highway Administration	47.0	49.3	47.3	40.2	25.3	28.0
Federal Railroad Administration	28.2	33.6	34.7	33.0	46.4	48.0
Materials Transportation Bureau (Office of Hazardous Materials Transportation)	9.0	10.0	7.5	6.8	6.8	7.5
Total	236.6	227.4	262.9	138.2	132.5	110.5

NOTE: The term "work-years" refers to the aggregate annual time spent by all inspectors in a mode.

SOURCE: Office of Technology staff—based on Department of Transportation Annual Reports.

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[19] U.S. Department of Transportation, *Annual Report on Hazardous Materials Transportation, Calendar Year 1984* (Washington, DC: 1984), p. 42.

[20] Mark Abkowitz and George F. List, "Hazardous Materials Transportation Flow and Incident/Accident Information Systems," OTA contractor report, January 1986.

*Average annual expenditure reported by training organizations in the Department of Transportation/Federal Emergency Management Agency study.

program provides a model for a cost-effective federally supported emergency response training program. It made good use of existing resources, provided uniform training, used train-the-trainer techniques, and required that States adopt Federal regulations, designate a State lead agency, and participate in funding. However, total Federal SHMED expenditures were $3 million for a program that reached 26 States, and perhaps less than half the national enforcement officer population of about 500,000; a totally different level of need exists for emergency response training.

OTA estimates that the minimum training time needed for an introductory course for first response to hazardous materials emergencies is 2 days, assuming that the trainees are already trained firefighters, enforcement officers, or medical technicians.* Costs for this basic training depend on where and how it is carried out. Table 1-3 shows estimates for an annual training program to begin addressing State and local emergency response training needs. **OTA concludes that an annual Federal funding level of approximately $5 to $7 million, added to $10 to $15 million derived from other sources and monies now being spent, could provide adequate Federal assistance, if existing resources are reorganized and tightly managed.**

Possible Federal funding sources include:

- general revenue;
- Federal funding programs related to hazardous materials transportation, such as the Surface Transportation Assistance Act (the fuel tax), the Nuclear Waste Policy Act, or the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund); and
- creation of a dedicated fund based on user fees, such as those generated by a permit or registration fee levied against hazardous materials industries.

The fuel tax is the most broad-based of the three special tax-based funds, and gasoline transport accounts for the largest dollar damages. Since truck accidents require the most frequent emergency response activities, tapping fuel tax funds to support emergency response training provides for a degree of equity. The Nuclear Waste Policy Act provides some funds for State and local activities related to transportation, but such funds are generated by nuclear utilities, and their shipments represent far less than 1 percent of total annual hazardous materials shipments. Superfund already has substantial claims against it and specifically excludes transportation from some programs.

If used to fund emergency response training, a Federal registration or permit program could have major adverse impacts on similar State and local activities, an issue discussed further in the section on regulatory consistency. Moreover, the administrative costs for such a Federal program need to be carefully considered. **If industry is to support a new user fee to fund training, it will require assurance that:**

- **the amounts assessed relate to the magnitude of local training needs,**
- **the funds reach those most in need,**
- **a fixed limit is placed on the amount it must contribute,**
- **local jurisdictions make maximum use of existing regional resources and participate in the funding effort in some way, and**
- **no individual State or local fee programs are implemented for this purpose in participating jurisdictions.**

Two independent groups have endorsed creation of a dedicated fund, generated by user fees levied against shippers and carriers to support State and local hazardous materials program development and emergency response training. The groups are the Hazardous Materials Coalition, comprised of State and local government organizations and some industry representatives, and the National Hazardous Materials Transportation Advisory Committee, formed by the Secretary of Transportation and comprised of State and local government officials and representatives of industry and labor. Both groups recognize that many jurisdictions already impose registration or permit fees, using them for a variety of purposes frequently unrelated to emergency response, and that requiring payment of another such fee is unacceptable to many industries.* Restrictions on their own fee programs, suggested for jurisdictions choosing to benefit from the Federal fund, may be difficult for States to accept.

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*OTA calculations, based on interviews with emergency response trainers and OTA staff experience with four types of emergency response training: industry, jointly sponsored public and private courses for community first response personnel, Federal training for public response, and Federal training for Federal response.

*Two major industry groups, the Association of American Railroads (AAR) and the Chemical Manufacturers Association (CMA) have opposed such a fund in the past. CMA is modifying its opposition, requesting further study to quantify the need; AAR remains opposed.

Equity in apportionment of funds is an important consideration, although an appropriate basis is difficult to determine. Funds could be apportioned to States on the basis of population or on the basis of hazardous materials transportation density. However, areas such as the Gulf Coast; California; and the Pennsylvania, Ohio, Indiana, and Illinois corridor, which have the largest amounts of hazardous materials traffic, also have the largest number of industry response teams. (See figures 1-1, 1-2, and 1-3.) Moreover, the need for emergency response training is often not recognized in small urban or rural areas, where the probability of an accident is low, but where the consequences of an accidental spill for untrained response personnel could be severe. Finally, jurisdictions that already have well-developed emergency response capabilities have emphasized to OTA that they need financial assistance to maintain training levels and equipment.

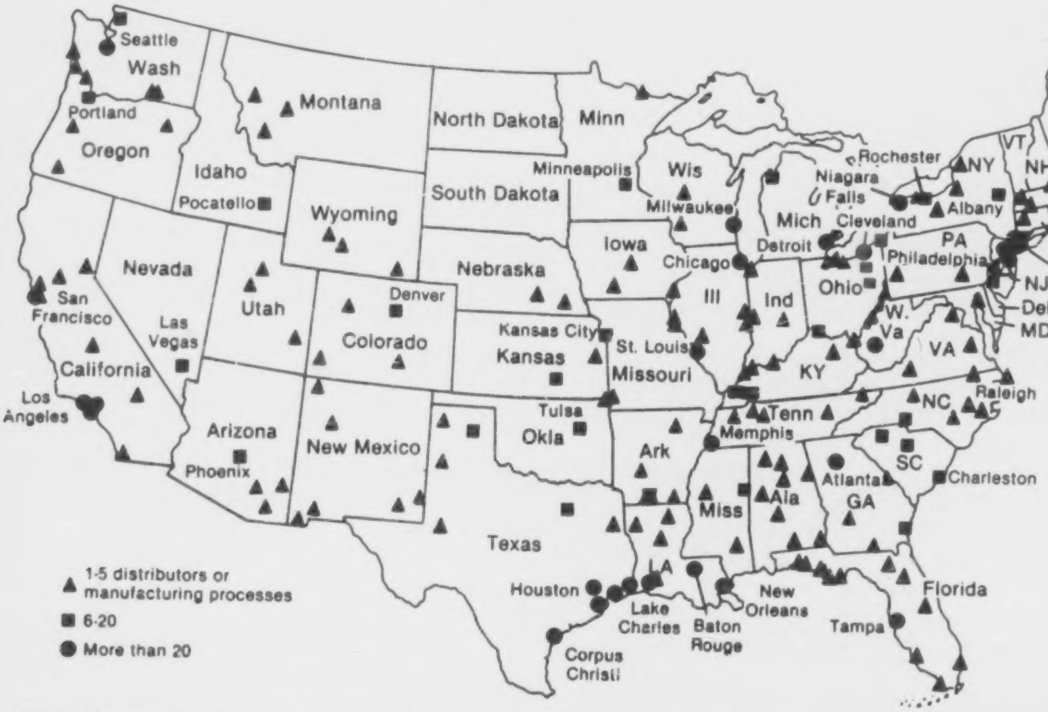
Additional local industry involvement in development and delivery of community hazardous materials emergency response training could be encouraged to defray training costs. Support from Federal and private sources for financial assistance to State and local jurisdictions will be more readily forthcoming if jurisdictions can show that they:

- have developed an emergency response plan;
- know what their training needs are;
- have local matching funds or resources available; and
- have cooperated with neighboring jurisdictions in such efforts as joint planning, information collection, and mutual aid agreements.

Regulatory Consistency

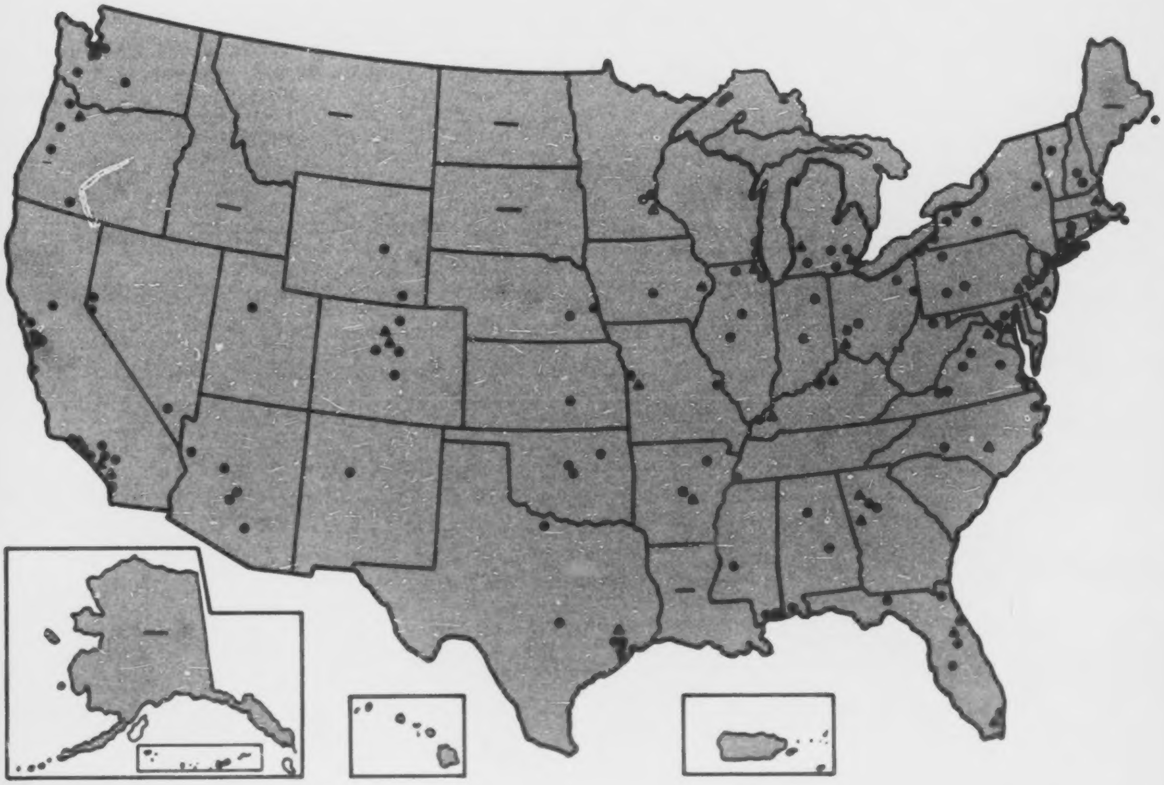
The authority granted to DOT under the Hazardous Materials Transportation Act (HMTA) to regulate hazardous materials is comprehensive. However, putting aside questions of whether RSPA has adequate staff for program administration, several

Figure 1-1.—The Chemical Plants: Where They Are



SOURCES: Environmental Protection Agency, SPN Directory of Chemical Producers, Chemical Week Buyers Guide, Chemsources U.S.A., individual chemical companies.

Figure 1-2.—Public Hazardous Materials Respose Teams



▲ - County response teams
● - City/town response teams

SOURCE: International Association of Fire Chiefs (IAFC) survey and OTA Staff.

decisions made by DOT about how to exercise its authority have limited the applications of its regulations, motivating international organizations and State and local governments to act where they saw a need.

First, DOT has chosen not to apply the regulations to solely intrastate motor transport except for hazardous wastes and substances and flammable cryogenics in portable tanks and cargo tankers.[21] Many public officials, common carriers, and large private carriers that have both interstate and intrastate activities are surprised to learn that most carriers operating solely intrastate are exempt from many DOT regulations. For example a release of a hazardous material by an intrastate trucking company need not be reported to DOT, and second- or third-hand cargo tankers that no longer meet Federal requirements may be operated within some States. While States accepting MCSAP funds are required to apply 49 CFR in enforcement actions against intrastate carriers, this does not ensure that the reporting requirements and container regulations will be applied.

Second, DOT has not exercised its authority to establish a registration program for shippers and carriers. This has meant that it does not have complete data about the extent of the group it regulates and that the portions of the data that would be useful to State and local officials are not available.

Since the early 1970s, State and local governments have been increasingly active in regulating shipments

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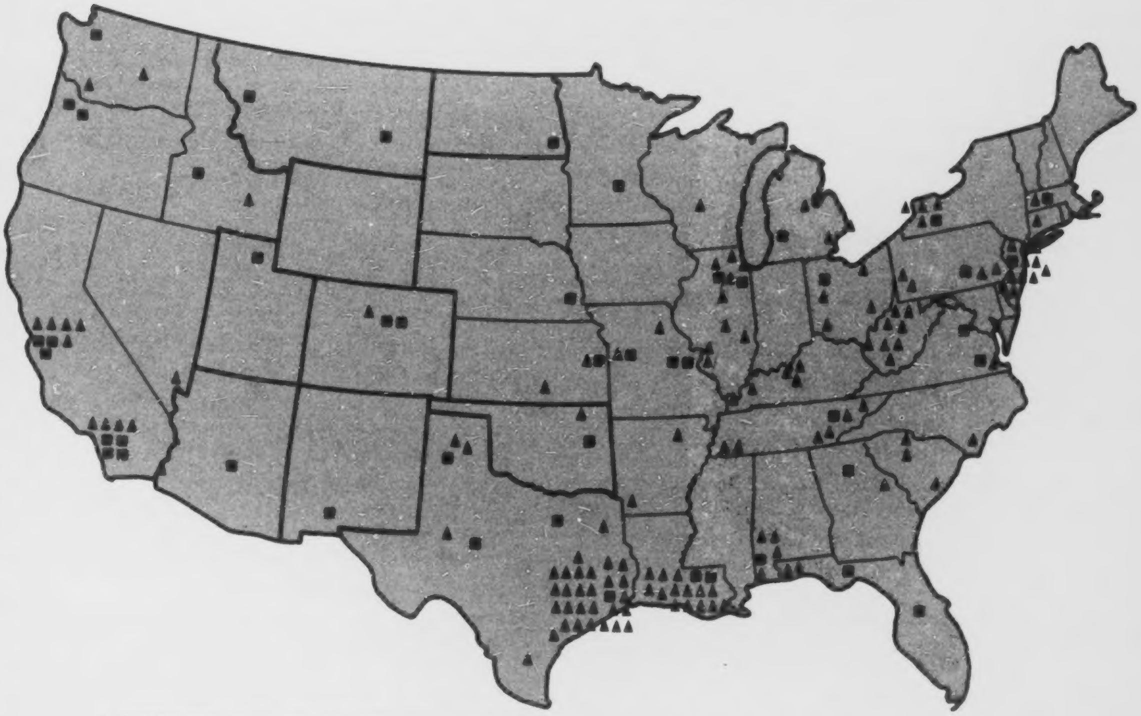
[21] 49 U.S.C., Part 171.1 (a).

Figure 1-3.—CHEMNET Emergency Response Team Locations



▲ CHEMNET chemical industry emergency response teams
■ CHEMNET contractor emergency response teams

SOURCE: Chemical Manufacturers Association.

of hazardous materials to supplement Federal regulations and enforcement and to ensure adequate safety for their jurisdictions. Because each was formulated to meet immediate and separate goals, State programs affecting hazardous materials transportation, like their Federal counterparts, are now characterized by a multiplicity and diversity of activities and areas of jurisdiction. Responsibilities are divided among State ~~utility~~ commissions, transportation, health, environmental, and emergency preparedness agencies. Moreover, great variation among State laws and regulations exists, even though most States have adopted 49 CFR wholly or in part. Finally, the enormous differences in State requirements for truck driver's licenses mean there is no assurance that a qualified driver is behind the wheel of a truck carrying hazardous materials.

Furthermore, finding Federal data lacking in the necessary detail, State and local governments and transportation facilities have enacted a variety of regulations intended to provide information they need for emergency response planning, enforcement activities, and development of local routing restrictions. The result is that shippers and carriers have to comply with multiple State and local registration, licensing, permitting, and shipment notification requirements. Additionally, differing right-to-know laws authorizing public officials to obtain information from facilities within their jurisdictions have been passed at State and municipal levels. The provisions of Good Samaritan laws also vary from State to State; requiring that emergency response personnel, particularly special industry teams that operate in more than one State, be aware of these differences. This wide variation in regulations is clearly at odds with the intent of the HMTA.

Another important regulatory activity of State and local governments is the designation of routes that must be followed by transporters of hazardous materials. Existing highway routing policies established by DOT permit State and local route designations to accommodate local traffic conditions. The Federal highway routing rule for radioactive materials requires the use of Interstate highways or alternate routes designated by State agencies, while a more general requirement for nonradioactive materials instructs carriers to avoid heavily populated areas. Although DOT guidance documents advise States and localities to use explicit safety criteria and involve all affected parties early in making route designations, reaching a consensus is often difficult. In some cases, rerouting has shifted risks to jurisdictions lacking emergency response capabilities; other designations have been contested because affected communities or States were not consulted.

The assumption of greater regulatory and enforcement responsibilities has meant heavier financial burdens for States and localities. Although the SHMED program and MCSAP have provided many States with some funds for the development of hazardous materials enforcement programs, local governments usually do not benefit directly from Federal grant programs to the States. To pay for their inspection, enforcement, or emergency response programs, many States and municipalities require shippers and carriers of hazardous materials to pay a fee when they register or apply for a license or permit. As most State and local fees and requirements apply to highway shipments, the trucking industry has been affected most heavily, and carriers argue vigorously that compliance with differing laws and regulations is time-consuming and expensive.[22] The costs include not only payment of registration, permit, and licensing fees ranging from several dollars up to $1,000 per shipment, but also expenses incurred by special staff to keep track of requirements that continuously change. In addition, carriers point out that certain requirements, such as curfews imposed on some special shipments, cause delays and increase risks. By diverting shipments around their own boundaries, jurisdictions imposing such requirements shift risks to other States and communities.

Photo credit: Maryland Transportation Authority

Bridge, tunnel, and turnpike authorities in many areas restrict the movement of hazardous materials, as illustrated by this photograph taken near the Baltimore Harbor Tunnel.

The roles played by States and localities in the regulation of hazardous materials transportation have grown considerably since the HMTA was passed. The act provided the Secretary of Transportation with broad authority and specified that State and local requirements inconsistent with Federal law and associated regulations should be preempted except under certain circumstances. The legislative history of the HMTA indicates that Congress intended to preclude a multiplicity of State and local regulations, exactly the types of varying and conflicting regulations that now exist. While most State and local governments understand and agree with the need for uniform regulations, especially in areas related to containers and hazard communication, they have also found that DOT activities have not provided adequate safety levels in their jurisdictions. They have thus taken the steps they consider necessary to control the risks associated with the transportation of hazardous materials.

There have been no comprehensive efforts to date to resolve interjurisdictional differences. Resolving questions of inconsistency between local, State, and Federal regulations, a task traditionally left to the courts, has been the focus of an advisory administrative review process, established by DOT in 1976. The 16 inconsistency rulings issued since 1978 indicate that DOT believes that permissible State and local regulatory authority is limited to traffic control and eliminating or reducing safety hazards peculiar to local areas, and that each State and locality must assess the impacts of a requirement, such as a routing rule, on other jurisdictions. However, as the DOT inconsistency ruling process does not preclude judicial review, a number of the cases examined by DOT have also been the subjects of lawsuits.

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[22] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, op. cit.

While case-by-case reviews by DOT and the courts are time-consuming and costly, they provide some criteria for assessing the validity of certain types of laws and regulations. However, OTA believes such reviews will not prevent continued adoption of differing State and local requirements, as these provide both needed revenue and valuable data. Any policy or legislative changes to relieve the present situation must address both the financial and informational needs of State and local governments, as well as ease the burden faced by interstate shippers and carriers.

Carrier associations, insurance industry representatives, and State motor vehicle administrators and enforcement personnel have voiced strong support for a national truck driver's license requiring special training. Congress could authorize the development of such a license with special certification requirements for all hazardous materials, including gasoline. Prerequisites for a license should include training and a clean record, and driver certification could be linked to specific types of vehicles. Uniform license requirements and training standards could be developed by DOT, but States would be responsible for issuing licenses and administering the training requirements. State license fees could be set to cover program costs. California has already developed a graded truck driver's license program. A program created by the European Common Market countries requires a hazardous materials driver's license but allows each country to pass its own implementing legislation.

OTA concludes that even if DOT exercised its authority to establish a registration program for its own purposes, the information collected under the program would not completely meet the data needs of States and communities. Thus, **Congress might require development of national guidelines for State information-collection programs in three areas: registration—to determine the number and location of hazardous materials shippers and carriers; licenses or permits—to obtain assurances of fitness from shippers and carriers; and notification—to obtain information on the types of hazardous materials passing through a community or region**. Involving Federal, State, local, and industry representatives in developing both the guidelines and a standard form for requesting information,* would permit consensus and a degree of uniformity. Once States have adopted the guidelines, localities could obtain the information they need from their State agencies. However, bridge and tunnel authorities have special information needs that may include prenotification of certain high-hazard shipments. Assuming that alternative sources of financial support are provided for enforcement and emergency response, State and local fees could be limited to amounts sufficient to cover program administration costs. An annual compendium of State, local, and special authority requirements and contacts would be very useful to interstate shippers and carriers. Industry, DOT, and the States might jointly develop the necessary data for such a compendium.

The broader issue of varying State hazardous materials laws and regulations should also be addressed. Complete information about the scope of existing State laws and regulations pertaining to the transportation of hazardous materials is not presently available. While many States have adopted 49 CFR, some have excluded certain types or quantities of hazardous materials and certain intrastate highway shipments. Conversely, other jurisdictions have established regulations more stringent than the Federal ones. **OTA concludes that an assessment of State hazardous materials laws and regulations to determine whether they are more or less stringent than Federal regulations would be a useful first step toward greater regulatory consistency**. BMCS has already begun, at congressional request, a 5-year study program that will lead to greater highway regulatory uniformity, but only in some areas.[23]

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*The Uniform Waste Manifest, developed jointly by the U.S. Environmental Protection Agency and the U.S. Department of Transportation, is one possible model.

[23] This review is authorized by the Motor Carrier Safety Act of 1984, Public Law 98-554, 98 Stat. 2829. State guidelines for compiling, analyzing, and submitting their laws, regulations, and other information were published by the Bureau of Motor Carrier Safety on Jan. 10, 1985 (50 F.R. 1243).

BMCS is compiling and reviewing State motor carrier laws to determine those that are more or less stringent than Federal requirements in the areas of driver qualifications and training, hours of service, and equipment maintenance. As part of the process, State laws will be reviewed by a panel convened by the Secretary of Transportation. State laws that are less stringent than their Federal counterparts will be preempted; a law that is more stringent will not be preempted unless it has no safety benefit, poses an undue burden on interstate commerce, or is incompatible with Federal regulations. Another study of State motor carrier laws related to finances is being conducted by the National Governor's Association for DOT. Congress could extend these reviews to encompass State hazardous materials regulations or initiate a separate process. **Congress might also wish to require DOT to reduce emphasis on inconsistency rulings, which are issued after a regulation is in place, and to provide technical and policy assistance to States or communities during the process of developing regulations.**

Congress might also consider requiring the expansion of those parts of 49 CFR promulgated by RSPA, such as reporting requirements and container regulations, to cover all intrastate highway transportation. Such a requirement would allow RSPA regulations to address safety issues more comprehensively. However, if this approach is adopted, States are likely to insist that the same preemption criteria as mentioned above be applied.

Routing is an extremely important accident prevention tool available to State and local governments. Although it is likely that developing a routing scheme that enhances overall safety will be a difficult process for some regions, experience in Portland, Oregon, demonstrates that it is possible. The existing routing regulation for nonradioactive hazardous materials could be amended to provide more explicit guidance to communities. The use of existing DOT routing guidelines, which contain a risk assessment methodology and recommend interjurisdictional consultation, could be required. States interested in designating alternate routes to those approved by NRC for shipments of radioactive materials are already required to follow the DOT guidelines embodied in the ruling known as HM-164. The development of criteria for routing shipments of radioactive and other hazardous materials by rail and water might also be considered. **DOT could provide technical assistance to States and communities for applying risk assessment criteria and working through the route-selection process to avert the need for legal action.**

Data and Information Programs

Federal, State, and local governments need data to help them set regulations, plan for emergency response and accident reduction, and target enforcement efforts. Data and information systems pertaining to hazardous materials transportation are kept by many Federal agencies, regional Federal offices, different departments of State governments, and even some local government offices.

Hazardous Materials Flow Information

The most basic data needed for all of these activities are the identities and locations of suppliers, manufacturers, and carriers of hazardous materials. A governmental entity may acquire this information by requiring such firms to register, by conducting an inventory, or by searching existing data. Although it has the authority to do so, RSPA does none of these things and thus has no complete record of the firms it regulates. When they discover that DOT cannot provide them with this important information, State and local governments often impose their own registration requirements or conduct their own inventories. New Jersey and Maryland have completed statewide inventories; Pennsylvania, California, and Denver require registration. These activities, when undertaken by individual States, are costly and time-consuming for both jurisdictions and industry.

To determine what alternative data resources exist at the Federal level, OTA examined current databases. Only one Federal multimodal database exists—the Commodity Transportation Survey, maintained by Bureau of the Census. For a summary of the surveys of data resources on commodity flow, see table 1-5. The nine regional divisions used in the national databases are shown in figure 1-4. Highlights of the commodity flow analysis performed by OTA contractors include the following:

- Truck transport accounted for more than 60 percent of all hazardous materials transport (ex-

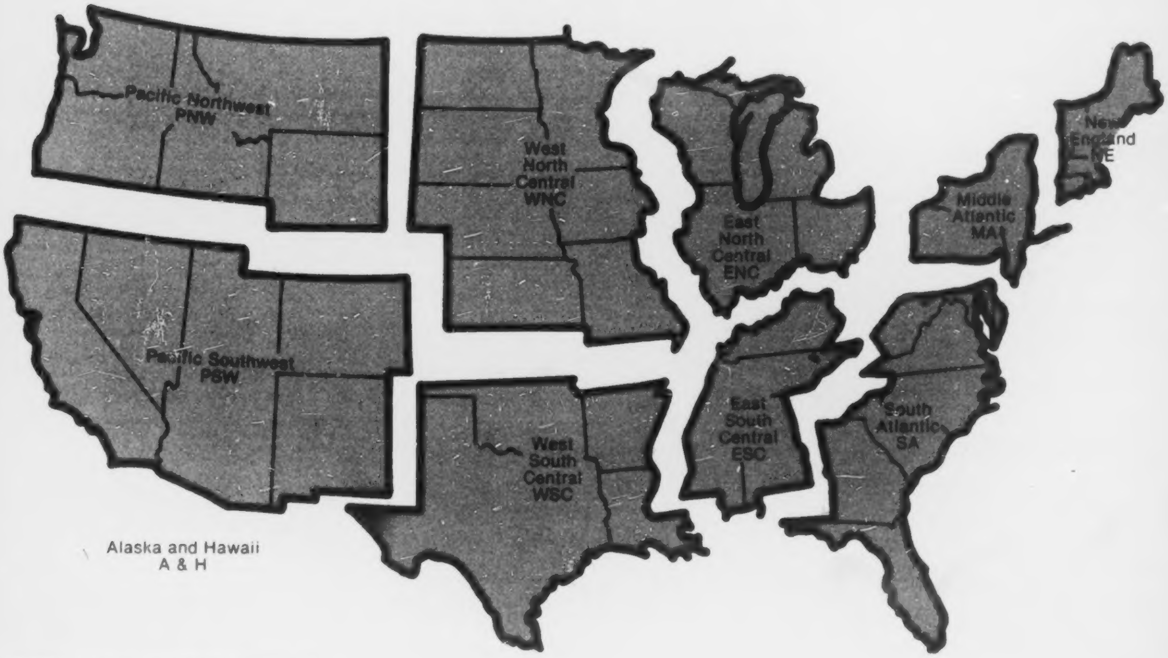
Table 1-5.—Commodity Flow Databases

Databases	Kept by	Years	Modes	Commodity codes	Conversion table	Strengths	Weakness/drawbacks
Commodity Transportation Survey (CTS)	Bureau of the Census	1977	All	5-digit STCC	Yes	• Multimodal • Consistent selection procedure for all sample data points for all modes • Cross-checked against the census of manufacturers	• Only 5-digit level of commodities • No hazardous materials flags • Only shipments from manufacturing sites to first destinations • Only "principal" mode is reported
Truck Inventory and Use Survey	Bureau of the Census	1977, 1982	Highway	Simple classes	No	• Covers all trucks used in the United States • Contains hazardous materials-related data items • Sample biased toward heavy trucks	• No flow data • Only rudimentary commodity information • Tractor database, not a trailer database—reflects tractor use, not trailer use
Motor Carrier Census	Bureau of Motor Carrier Safety, FHWA	Most recent 5 years	Highway	Hazard classes	No	• Comprehensive listing of carriers and truck fleet operators	• No flow data • Mileage and fleet size data are sparse
TRANSEARCH, FREIGHTSCAN, etc.	Consulting firms	Varies	All	Varies, up to 7-digit for rail	Yes	• Cross-checked against other production/consumption data • Melding of the best available for each mode	• Truck flows predominantly based on the CTS data (see above) • Not in the public domain
National Motor Truck Database	Consulting firms	1977 to present	Highway	Varies, up to 7-digit STCC	Yes, where commodity code is provided	• Focuses on long-distance highway flows • True flow data • Describes the vehicle used to carry the commodity	• Purposely excludes short-haul truck movements, especially in the Northeast • Not in the public domain
Waybill File	Interstate Commerce Commission	At least past 12 years	Rail, TOFC/COFC	7-digit STCC	Yes	• Well-organized sample (1%) of all rail flows • Database is consistent enough to allow trend analyses • Contains some routing information	• Not all hazardous material flows use the special Hazardous Materials STCC
Waterborne Commodity Statistics	Army Corps of Engineers	At least 12 years	Water, domestic and international	4-digit WCSC code	Only to a limited extent	• "100%" sample of all vessel movements • Complete routing information	• Only 163 commodity codes in all, so level of detail is weak • Conversion table has some incorrect cross-references
TRAIN II	Association of American Railroads	Current	Rail, TOFC/COFC	7-digit STCC	Yes	• "100%" data on all movements for participating railroads • Routing information	• Not specifically designed to record car movement histories • Not in the public domain
Hazardous Waste Shipment Data	States, for EPA	Varies	Primarily highway	Either EPA codes or OHMT	No	• "100%" sample of all hazardous waste shipments • Actual flow data	• Many States do not computerize the data • No consistency to commodity code usage • No routing information

ACRONYMS: EPA = U.S. Environmental Protection Agency; FHWA = Federal Highway Administration; OHMT = Office of Hazardous Materials Transportation, Research and Special Programs Administration; STCC = Standard Transportation Commodity Code; TOFC/COFC = trailer on flatcar (piggyback)/container on flatcar; WCSC = Waterborne Commerce Statistics Center (U.S. Army Corps of Engineers).

SOURCE: Office of Technology Assessment.

Figure 1-4.—Regions Used in This Analysis



SOURCE: Office of Technology Assessment.

cluding pipeline) in 1982. Gasoline shipments accounted for almost half of the total truck tonnage.

- The average trip length for gasoline trucks was 28 miles, making them predominantly local and intrastate. The average trip length for trucks hauling chemicals was 260 miles, making these trips regional and more likely to be interstate.
- About 90 percent of truck shipments are *intraregional*, as are a high proportion of rail and water shipments.
- The three regions with the greatest concentration of shipments are West South Central, Middle-Atlantic, and South Atlantic (see figure 1-4), with North Central not far behind.

While these data are instructive in the aggregate, they give State and local planners only some of the information they want about their transportation networks.

OTA finds that Federal data-collection activities are numerous and diverse, each providing modal transportation data of varying completeness. These activities provide useful information on regional flows of hazardous materials transportation, if carefully analyzed, and a sound basis for additional State or local commodity flow data collection. OTA experience in analyzing Federal databases for this report establishes that additional Federal data is unnecessary, that data integration is not a significant technical problem, and that comparative data on commodity flow can be developed.

City officials and planning personnel have been the most vocal in expressing to OTA a need for a national commodity flow data resource. Although an annual printed summary produced by DOT is most frequently mentioned as an appropriate format, some requests have been made for a real-time notification system for especially hazardous shipments. However, emergency response officials consulted by OTA generally prefer to do local inventories and transportation surveys to ensure that their personnel are prepared for any eventuality. They point out that annual summaries describe only last year's shipments and that detailed real-time information would be overwhelming to track and useless for planning and preparedness.[24] As one fire chief said: "What am I supposed to do? Follow the truck around waiting for an accident to happen?"[25] On the other hand, a few local officials and planners want real-time tracking of hazardous materials shipments and have called for the development by DOT of a publicly accessible database to provide this information.[26]

A real-time data system is probably the only way to keep abreast of shipments. Many hazardous materials orders are for truck delivery within 36 hours or less, while other shipments are seasonal, related to agricultural or manufacturing cycles. Finally for economic reasons, customers may change supply sources overnight, rendering periodic data collection instantly obsolete. However, the technological groundwork for a system to track hazardous waste shipments, which represent less than 1 percent of hazardous materials shipments, in real time has been developed by a private firm, although the system has not been tested in operation. Even if the technical difficulties for implementing such a system for all hazardous materials could be resolved, the cost has been estimated to be more than $100 million.[27] **Online telephone access to real-time information on all hazardous materials shipments is neither feasible nor cost-effective, OTA concludes.**

OTA finds that although no current Federal resource can provide shipment information with the specificity desired by State and local jurisdictions, annual DOT summaries of aggregate regional shipments could provide useful regional and State commodity flow data. However, while development of a real-time database to track highly hazardous shipments only is technically feasible, its utility for emergency response is questionable. **Finally, OTA concludes that locally conducted data collection, such as hazardous materials facilities inventories and transportation surveys, is useful and has value beyond the data it produces. The process of gathering information provides data for planning and emergency response purposes and has the additional benefit of acquainting the concerned parties with each other and with the hazardous materials transportation in their areas.** Some Federal financial assistance for State data collection is available through existing grant programs. Community right-to-know laws are useful tools for State and local governments in obtaining data, and national right-to-know legislation would bolster implementation of such laws where industry resistance remains.

If Congress chooses to provide support for data gathering, several options are available. DOT could be required to exercise its authority under 49 CFR, Section 1805(b) and develop a registration program for hazardous materials shippers, transporters, and container manufacturers. **OTA finds that a registration program would provide DOT with essen-**

Photo credit: Research and Special Programs Administration, DOT

Facility inventories are an important source of information for State and local planners, city officials, and emergency response personnel.

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[24] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, op. cit., ch. 4.

[25] Thomas Hawkins, Jr., Chief, Arlington County Fire Department, Arlington, VA, personal communication, January 1986.

[26] The National League of Cities (NLC) has retained in its transportation position paper a request for a U.S. Department of Transportation report on commodity flow. Barbara Harsha, NLC transportation staff, personal communication, January 1986.

[27] John Mulholland, Source Data Network, personal communication, November 1985.

tial information about the community it regulates and with general commodity flow information that could be helpful to State and local jurisdictions. DOT needs the information such a program could provide to help set priorities for rulemaking, research, and enforcement actions. A modest registration fee could be imposed to cover costs of administering the program.

In addition, Congress could require DOT to integrate, analyze, and report annually on trends from relevant Federal databases kept by the modal administrations and the Bureau of the Census. For this effort to be effective:

- the collection of data on truck movements would need to be improved;
- cross-reference keys or bridge tables for the commodity codes used by different agencies and in 49 CFR would need to be created, or each agency might be required to use a common code for commodities; and
- sufficient funds would have to be allocated to support the effort. OTA estimates that the equivalent of one man-year of effort, between $75,000 and $100,000, would provide a modest start.

A summary of the commodity flow data developed in comparison to DOT accident data in the required annual report to Congress would be useful.

Spill and Accident Data

By law, RSPA must report to Congress annually on the safety of hazardous materials transportation, a requirement that, at a minimum, necessitates good records of hazardous materials accidents and spills. A complete safety analysis would also require some reliable estimates of the total amounts of hazardous materials shipped annually by each mode, but as pointed out above, that information is not available.

Hazardous materials incidents or releases,* defined as any unintentional release during interstate transportation, loading, unloading, or temporary storage related to transportation, must be reported to RSPA in writing within 15 days. The written reports serve as the basis for the HMIS, the sole DOT database specifically on releases, casualties, associated damages, and related information on the material, container, cause, and location of the release. All rail, highway, nonbulk water, and air releases occurring during interstate commerce are supposed to be reported on the RSPA Form 5800.1; intrastate highway and bulk marine transport are significant omissions.

Numerous modal hazardous materials release and accident reporting systems had been developed prior to 1971, when HMIS became the official recordkeeping system for release data. The Coast Guard, the National Highway Traffic Safety Administration, FRA, and BMCS, continue to require reports of modal accidents. Coast Guard reporting requirements are particularly extensive, and most water releases are reported to one or another of the Coast Guard systems rather than to RSPA. In addition, carriers are required to make an immediate telephone report to the National Response Center (NRC), staffed 24 hours a day by the Coast Guard, when a release has resulted in serious consequences, such as a fatality or property damage over $50,000, as a direct result of the hazardous material.[28] NRC has two 24-hour toll-free telephone lines to receive notifications, and several other lines to relay calls to emergency response agencies. Carriers involved in a release sometimes telephone CHEMTREC, a chemical emergency center maintained by the Chemical Manufacturers Association. CHEMTREC is required to notify NRC of significant releases; however, a call to CHEMTREC does not fulfill the RSPA written reporting requirements. Despite this, the CHEMTREC toll-free telephone number is the only telephone number given in DOT's *Emergency Response Guidebook*;* **the NRC telephone number is not listed there.**

Telephone reports received by NRC are logged every evening into a computer at the DOT-Transportation Systems Center (TSC), where the information is retained and managed by RSPA. Nevertheless, RSPA does not include most water releases reported to NRC in its annual report.

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*Releases are referred to as incidents in 49 CFR reporting regulations. The other release and accident databases studied by OTA all have different definitions of an incident. For the sake of clarity, all Research and Special Programs Administration incidents will be called releases in this report.

[28] 49 CFR, 171.15.

*The *Emergency Response Guidebook*, developed and widely distributed free by the U.S. Department of Transportation (DOT), gives basic hazard and first response information for hazardous materials regulated by DOT.

Although release reporting is a regulatory requirement, OTA found evidence that the compliance rate is low. The incentive for reporting as required is to avoid the possibility of a civil or criminal penalty; these can include fines ranging up to $25,000 and prison terms of up to 5 years. DOT policy requires consideration of the violator's ability to pay when penalties are assessed. When violators are penalized, the penalty level is frequently too low to deter future violations, because the costs of compliance are greater than those of potential penalties. Thus, some operators consider penalties to be an occasional cost of doing business.[29]

To assess the completeness and accuracy of the HMIS, OTA contractors compared it with relevant Federal modal databases, NTSB data, and State data resources. All of these data resources are available to DOT, with many of them housed at TSC. Through careful analysis of reports filed with DOT modal agencies, OTA contractors were able to determine whether or not hazardous materials were involved in the reported accidents, although data for air shipments are poor. Corrected for duplications and incomplete reports, these comparisons showed that for air and marine transport, the number of releases is underrepresented in the HMIS by factors of 10 and 20, respectively. For rail and Interstate highway transport, the number of releases is underrepresented by factors of 3 and at least 2, respectively. Comparisons of damage estimates in the databases lead OTA to conclude that annual damages are at least 10 times the HMIS figures, averaging more than $160 million a year.*

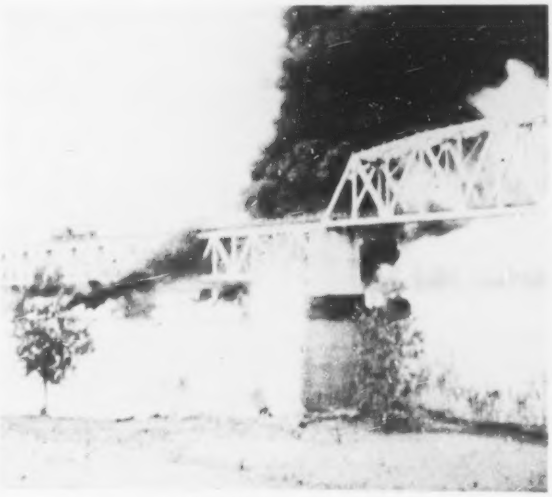

Photo credit: National Transportation Safety Board

Under DOT reporting requirements, releases occurring during bulk marine transport of hazardous materials are not included in the HMIS.

OTA finds that RSPA has an incomplete record of accidents and releases and has no documentable idea of how much hazardous material is transported. Moreover, RSPA officials regard data collection as a secondary function[30] despite its importance to risk, hazard, and regulatory analysis and to planning for technological and industrial changes. The HMIS is currently an inadequate database. It misses numerous releases recorded in other Federal databases because releases occurring during intrastate highway and bulk marine transportation need not be reported, the reporting requirement is not enforced, and no effort is made to gather accident data other than that reported on Form 5800.1. Augmenting and improving HMIS need not be extremely costly.

OTA analyses of flow and accident data indicate that relatively few of the HMIS data can be used as indicators, and that a major accident in any single year or on any mode can skew the data significantly. However, **when combined, current Federal accident and release databases provide more comprehensive information on the dimensions of hazardous materials transportation safety problems.** Data results from HMIS that appear to be reliable and are corroborated by other sources include the following:

- the majority of the releases occurred on the highway mode, and most occurred during loading and unloading, rather than over the road;
- corrosive substances have the highest accidental release rate;

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[29] National Conference of State Legislatures, *Hazardous Materials Transportation: A Legislative Guide* (Washington, DC: February 1984), p. 36.

*The Research and Special Programs Administration reports for 1976 through 1984 included 79,257 incidents resulting in $144,751,240 in damage. OTA calculations adjust this to 178,683 incidents resulting in $1.47 billion in damage for the 9-year period.

[30] Sherwood Chu, Deputy Director, Office of Hazardous Materials Transportation, Research and Special Programs Administration, U.S. Department of Transportation, personal communication, March 1986.

- gasoline truck accidents and releases are the most numerous and cause the greatest dollar damage; and
- human error, including speeding and other basic traffic violations, is the leading cause of releases and accidents.

Since trucks carry more hazardous tonnage annually than all other modes together, and there are many more trucks than other vehicles or vessels, the preponderance of truck-related releases is not surprising. A California study, being conducted for the State legislature, compared three separate databases and determined that at least 500 releases occur annually on the State highway system alone, excluding the city streets. Furthermore, the study showed that driver-related factors were the most significant contributory causes in over 50 percent of the accidents.[31] These results imply that addressing issues such as driver qualifications, training, and performance is essential for safety improvements.

In addition, the data show that reported accidents involving hazardous materials more frequently involve common carriers than private carriers and that they occur more often in Pennsylvania, Ohio, Illinois, and California than in other States. Memphis has the highest release rate for the air mode, reflecting the fact that it is a major air freight hub.

The intent of the HMTA clearly indicates the need for an adequate annual summary of the safety of hazardous materials transportation, making improvement to the HMIS an urgent issue. Congress could require DOT to extend accident reporting requirements to all hazardous materials spills over a certain threshold whether they occur during interstate or intrastate transport and regardless of mode. Furthermore, a coordinated national spill reporting center, with reporting procedures and common data report fields that must be implemented by all Federal agencies, could be designated. The DOT National Response Center or the HMIS staff at RSPA provide natural homes for this coordinating role. Moreover, if formats including common data fields were decided on, accident reports collected at the State level could be submitted periodically to the regional DOT or EPA office. The regional Federal offices could provide annual updates to the national center. Several regional EPA offices already work with the States in their regions and have good computerized reporting systems. Reporting requirements need to be more strictly enforced, and release reports should be cross-checked at the regional level for accuracy and completeness before being submitted to a national data-collection center.

DOT could be required to document, in its annual reports to Congress on the transportation of hazardous materials, accidents by State, container types, mode, and cause. Activities now underway at DOT to improve the RSPA spill report, Form 5800.1, and to coordinate with modal administrations to develop common data fields that are less open to subjective interpretation, should make the form reflect more accurately the causes and details of the spill. Congress might wish to require display in the DOT *Emergency Response Guidebook* of the toll-free number for the national report center as the place to call for reporting accidents.

Containers

The Federal regulatory standards for containers used to ship hazardous materials are comprehensive, requiring that the packaging be adequate to prevent release of its contents during transportation. Indeed, standards for containers for highly radioactive materials are set to ensure the packages withstand severe accident conditions without a dangerous radioactive release. To determine the adequacy of the containers used for transportation, OTA studied the accident and release records for the containers, the modal characteristics affecting the choice of containers, and the regulations governing them. The examination included the unique container issues associated with the transportation of radioactive materials, including spent nuclear fuel, as well as packaging for more familiar hazardous materials such as chemicals, petroleum products, explosives, and poisons.

Containers for Radioactive Materials, Especially Spent Nuclear Fuel

About 2.8 million packages of radioactive materials are shipped annually, representing between 2 and 3 percent of the Nation's annual hazardous materials shipments. About two-thirds of these shipments are for medical purposes, with the balance for industrial and research activities and the nuclear fuel cycle.* [32] About 7 percent of all shipments are classified as wastes, with the vast majority being low-level wastes.[33]

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[31] Linda Turnquist, Analyst, California Transportation (CALTRANS), personal communication, March 1986.

While the primary Federal regulatory responsibility for shipments of radioactive materials lies with DOT, NRC and DOE also have specific responsibilities. Under its authority, DOT has issued regulations covering all aspects of transporting radioactive materials, including the containers, the mechanical condition of the transportation vehicles, and the training of personnel, as well as the routing requirements, package labels, vehicle placards, and shipping papers.

Under a Memorandum of Understanding, NRC and DOT cooperate to regulate containers for radioactive materials. NRC, under its own legislative authority, is responsible for regulating, reviewing, and certifying the packaging and certain transportation operations for shipments of fissile and radioactive materials that must be packaged in very secure packages, called Type B containers, when such shipments involve NRC licensees.[34]

DOT sets regulations for all other packaging for radioactive materials in consultation with NRC. NRC approval of routes is required for shipments needing physical protection during transport to prevent theft or sabotage, but the routes chosen must be compatible with DOT regulations.

DOE has authority under DOT regulations (49 CFR 173.7) to approve the packaging and certain operational aspects of its research, defense, and contractor-related shipments of materials requiring Type B packages, although DOE is required to use standards and procedures equivalent to those of NRC. **It is in the procedural areas and instances where DOE has chosen to exercise its authority to use containers and procedures other than those certified by NRC that the greatest conflict between DOE and the States has arisen.** For example, officials from New York and New Jersey were outraged to learn in July 1985 that DOE had planned to use a cask that had not been certified by NRC for nuclear waste shipments from Brookhaven National Laboratories on Long Island.

Finally, DOD has separate authority for its radioactive shipments, similar to that of DOE. Three different Federal agencies thus can set standards for shipments of highly radioactive materials; two of them are shippers as well.

U.S. regulations for containers used for radioactive materials transportation are based on internationally accepted performance standards. International regulations and standards divide the materials to be shipped into three categories, based on their radioactivity levels:*

- low hazard or very low levels of radioactivity requiring "strong tight" containers,
- somewhat higher levels of radioactivity requiring secure containers called "Type A" packages, and
- fissile materials and those with very high levels of radioactivity requiring exceptionally durable containers called "Type B" packages.

Federal regulations limiting the radioactive contents for the commonly used strong tight and Type A containers are set on the assumption that the containers might break open in an accident and release some of the contents. In contrast, Type B packages are required to be sufficiently strong to withstand severe accident conditions, thus providing for safety largely independent of procedural and other controls on the shipment. To assure that Type B packages are adequately designed, constructed, handled, and loaded to protect public health and safety, NRC must approve and certify container designs and make certain that quality assurance procedures are implemented for their manufacture, operation, and maintenance. A summary of radioactive materials and packaging types appears in box 1A.

While Type B packages are the first and most important device for public protection, additional reg-

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*Shipments associated with nuclear power account for one-twentyfifth of all packages of radioactive materials shipped annually.

[32] Harold S. Javits, et al., *Transport of Radioactive Material in the United States*, SAND84-7174 (Albuquerque, NM: Sandia National Laboratories, April 1985).

[33] U.S. Environmental Protection Agency, "Sources, Amounts and Characteristics of Low-Level Radioactive Solid Wastes," *Low-Level Radioactive Waste Management*, EPA 520/3-79-002 (Washington, DC: May 1979).

[34] "Transportation of Radioactive Materials: Memorandum of Understanding," *Federal Register*, vol. 44, No. 128, July 2, 1979. Among the 23,000 Nuclear Regulatory Commission licenses are manufacturers and users of radiopharmaceuticals, oil exploration companies, and nuclear utilities and their supply industries.

*International Atomic Energy Agency, Safety Series 6, 1985, now contains a fourth category called "surface contaminated object" which is under consideration to become a U.S. category.

Box 1A.—Radioactive Materials and Packaging Types

Packages for radioactive materials are chosen based on the form of the material shipped and the degree of radioactivity of the material. There are two forms: normal-form and special-form. Most materials are classified as normal-form. These are not highly radioactive, and although they constitute about 87 percent of all radioactive packages shipped annually, they include only 10 percent of the curies. Special-form materials are generally encapsulated solids that present a hazard due to direct external radiation if they escape from the package. Although they constitute only about 13 percent of all radioactive packages, they encompass about 90 percent of all the curies shipped annually.[1] However, special-form solid material is not readily dispersible and has high physical integrity, and thus poses relatively little risk from inhalation or ingestion. The quantity of radioactivity in the material is indicated by four subdivisions: excepted or limited quantity, low specific activity, Type A, and Type B.

Excepted material is that which is so low in radioactivity that the hazards are negligible, and the materials can be shipped without special packages, shipping papers, or labels. Examples of such materials include smoke detectors, static elimination brushes, lantern mantles, luminous watch dials, and luminous exit signs. Excepted materials are regulated by the Department of Transportation (DOT).

Low specific activity (LSA) material is that in which the specific radioactivity is sufficiently low that the radiological hazard presented by inhalation or ingestion of the material is very small. LSA materials include such things as uranium mill tailings, uranium ore, natural uranium hexafluoride, some low-level wastes, and most laboratory and medical wastes. LSA materials must be contained in strong and tight packages which permit "no leakage of radioactive material under conditions normally incident to transportation." Wooden boxes, 55 gallon drums, and special tank trailers fit this criteria. Containers for LSA materials are regulated by DOT in consultation with the Nuclear Regulatory Commission (NRC). Some LSA materials, such as spent resins from reactors, are required to be packaged in NRC-certified Type A packages.

Type A packaging is intended to prevent the loss or dispersal of its contents when subjected to a specified set of "normal" transportation conditions. The conditions are actually more severe than the "normal" label implies, as shown in box 3C. Most radiopharmaceuticals for medical uses are packaged in Type A containers, as are radioassay materials used in research and medicine, and some wastes associated with reactor operation. Type A containers are regulated by DOT in consultation with NRC.

Type B packaging requirements are the most stringent. Type B containers are employed for the larger quantities and high-level radioactive materials. The Type B test sequence—drop, puncture, exposure to heat, and water immersion—is described in chapter 3. Type B packages are required for most fissile materials, spent fuel, highly radioactive waste, irradiated components, radioactive sources for medical therapy, industrial radiography sources, highly contaminated equipment, and power sources for pacemakers. Type B "overpacks" are frequently used for shipping many Type A packages when additional protection is required. NRC regulations contain the standards for Type B containers and certifies the designs used in their construction. DOT regulations allow the use of either the U.S. Department of Energy or NRC-certified Type B and fissile packages in commerce.

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[1] Harold S. Javitz, et al., *Transport of Radioactive Material in the United States*, SAND84-7174 (Albuquerque, NM: Sandia National Laboratories, April 1985).

ulations and requirements for transportation of spent fuel have been developed. NRC monitors the quality assurance programs of its licensees and requires operational checks, such as leak tests, for the containers prior to each use. NRC checks for compliance with regulations at its licensees' facilities, and its inspectors are on hand to monitor the beginning of any spent fuel shipping campaign. The stringency of NRC inspection and monitoring depends on the inspectors' judgment and confidence in the shipper's quality assurance programs, training procedures and thoroughness in following procedures.[35] NRC also conducts routine transportation checks for compliance with regulations, and in the period from July 1983 to June 1985, inspected more than 300 shipments of spent fuel.[16] As an added precaution, some States through which spent fuel shipments pass require inspection of shipments by State personnel as well.

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[35] C. MacDonald in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on Nuclear Materials Packaging Technology," unpublished typescript, Feb. 8, 1985, p. 142.

NRC also requires that the governors of affected States be notified in advance of commercial shipments of spent fuel and certain other highly radioactive materials. The information must include the shipper's name, a description of the material, and estimates of times of arrival at State boundaries. DOE notification procedures are much less explicit, and friction with many States has resulted from this departure from NRC procedures. Moreover, certain shipments that involve national security are exempt from the prenotification requirement.

Both DOT and NRC have the authority to impose fines for violations of regulations. However, the efficacy of the enforcement efforts of both agencies has been the subject of severe criticism. The level of NRC inspection is less a concern than the reliance placed on the judgment of individual inspectors and shipping company personnel. The process provides few outside checks,[17] a situation which under adverse circumstances could have potentially disastrous consequences.[18] Quality control during cask construction, maintenance, and operational checking, and vehicle operations during loading, transportation, and unloading requires vigorous, constant scrutiny to minimize risk and chances of an accident due to human error.

Because shipments of spent fuel, which are made by both rail and trucks, are of special public concern, Congress expressed particular interest in the adequacy of the regulatory standards that must be met by Type B containers. OTA analyzed these standards and shipping procedures in detail. Such shipments represent less than 0.001 percent of the total number of annual hazardous materials shipments, and the probability of an accident involving spent fuel is very low. The potential consequences must be based on technical estimates since no actuarial record exists for such an accident. Currently, somewhere between 100 and 300 shipments of spent fuel occur annually, as utilities shift stored spent fuel from filled cooling pools at one site to other storage pools, or as industry and DOE or DOD move fuel either for storage or research.

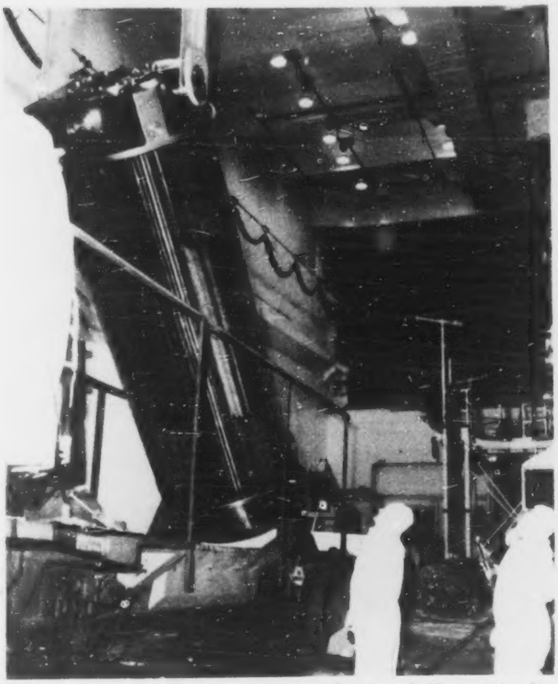

Photo credit: Transnuclear, Inc.

Personnel oversee the loading of the TN8 spent fuel cask, with a capacity of three fuel assemblies, onto a truck bed.

Type B Containers for Spent Fuel

The basic criteria for Type B packages, established in 1946 based on recommendations by the National Academy of Sciences, have been adopted by the International Atomic Energy Agency and 53 nations. Current NRC regulations provide a set of performance criteria for the packages, rather than specific design requirements. These remove the need to predict specific accident circumstances and provide a set of engineering test specifications for impact, puncture, temperature, immersion, and leak tightness that encompass the types of conditions that could occur in an accident.

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[16] Alfred Grella, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, "NRC Inspection Activities on Recent Shipments of Spent Fuel 1983 to Present," unpublished typescript of speech presented at the Spent Nuclear Fuel Transportation Seminar, Chicago, IL, Aug. 1, 1985.

[17] Union of Concerned Scientists, *Safety Second: A Critical Evaluation of the NRC's First Decade* (Washington, DC: February 1985), ch. 4, especially.

[18] Ibid., p. 155.

The most widely recognized Type B containers are the casks for transporting highly radioactive, spent nuclear fuel. Current casks are 10 to over 20 feet long and are constructed of two concentric, welded, stainless steel shells, each typically 1 to 2 inches thick, enclosing a gamma radiation shield of lead or depleted uranium metal and water or other hydrogenous material as a neutron radiation shield. These casks were designed to contain and ship spent fuel that had been removed from the reactor 4 to 5 months previously and that was still relatively radioactive. Potential technical improvements to the casks are examined as a normal part of international research and development and have been a focus of DOE- and NRC-funded research over the years.

The NRC cask certification process is, of necessity, painstaking and time-consuming. The proven safety record of NRC-certified casks, however, provides a degree of public confidence in casks. **OTA finds that technical evidence and cask performance in service indicate that NRC performance standards yield spent fuel shipping cask design specifications that provide for a very high level of public protection—much greater than that afforded in any other current hazardous materials shipping activity. However, meticulous adherence to the designs and specified procedures during cask manufacture and to required safety procedures during loading and transport are critical factors in ensuring public and environmental safety.** Transportation accidents involving shipments of spent fuel will inevitably occur. However, OTA concludes that the probability of an accident severe enough to cause extensive damage to public health and the environment caused by a radiological release from a properly constructed cask is extremely remote. **OTA further finds that fruitful areas for improvements in the overall safety of spent fuel transportation are to be found in the institutional, procedural, and operational controls and arrangements, such as quality assurance and quality control measures; maintenance activities; operator, handler, and driver training; and inspection.**[39]

Finally, OTA finds that continued research is needed in certain technical areas to determine where safety improvements could be effective. Such research needs include: the interface between the carrying vehicle and the casks, such as tiedowns and fasteners; additional and ongoing evaluation of real accident stresses as compared to those specified by the current regulations; and methods of extending accident modeling capabilities to encompass accidents more severe than those currently incorporated in the models.

Future Spent Fuel Shipments Under the Nuclear Waste Policy Act

Under the provisions of the Nuclear Waste Policy Act (NWPA) of 1982, DOE will take title to spent fuel from commercial utilities and be responsible for its movement, storage, and disposal, starting in 1998. DOE has established the Office of Civilian Radioactive Waste Management to plan and prepare for these activities.

As there will be some 90,000 spent fuel assemblies in U.S. spent fuel pools by that time,[40] DOE may be responsible immediately for a number of shipments to a repository or monitored retrievable storage facility. Depending on the type and carrying capacity of the casks ultimately constructed and certified for these shipments, DOE estimates that approximately 250 rail and 725 truck shipments will be required annually to move spent fuel from reactors in the eastern half of the country to a monitored retrievable storage facility or repository.[41] For NWPA shipments, DOE has agreed to meet DOT and NRC safety and security requirements in effect at the time and will use only transportation casks that have received an NRC certificate of compliance.[42]

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[39] This aspect was a persistent theme in both the OTA workshop and advisory panel meetings; see for example Richard Cunningham, Nuclear Regulatory Commission, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Transportation of Hazardous Materials Panel," unpublished typescript, June 27, 1985, p. 230.

[40] George Russ, Atomic Industrial Forum, Bethesda, MD, personal communication, 1985. See also U.S. Congress, Office of Technology Assessment, *Managing the Nation's Commercial High-Level Radioactive Waste*, OTA-O-171 (Washington, DC: U.S. Government Printing Office, March 1985), p. 28.

[41] U.S. Department of Energy, "Environmental Assessment for a Monitored Retrievable Storage Facility," *Monitored Retrievable Storage Submission to Congress*, vol. 2, RW0035, review copy, unpublished manuscript, p. 2.23.

[42] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Storage and Transportation Systems, "Transportation Institutional Plan," unpublished internal review draft manuscript, Mar. 3, 1986, pp. 3 and D-57.

A new generation of casks is being designed and tested and will be employed to move spent fuel to a national repository under NWPA. Although they must meet the same performance standards as current casks, the new casks are likely to have somewhat different physical characteristics from those of the current casks, because they will be designed to hold older, less radioactive spent fuel. It is thus likely that the next generation of casks will carry the maximum possible number of spent fuel elements within weight and safety limits, to reduce the number of shipments necessary. Innovations in materials and design have yielded nodular cast iron and monolithic steel casks now used in Europe. Some of these designs have been submitted to NRC for certification and are undergoing testing.

DOE is also examining the possibility of employing very large capacity dual-use casks; these offer an opportunity to minimize both the number of shipments and the handling of the spent fuel. Once the fuel has been removed from the reactor and placed in dry, onsite storage in these dual-use casks, the handling and worker-exposure risk would be reduced if the same casks could be used to transport the spent fuel to a repository. However, the NRC-specified test conditions for casks used for transportation are more stringent than those for storage casks, and although NRC has pending applications for certification of two such casks, none has yet been certified for both purposes.[43]

Moreover, questions will need to be answered about the effects of lengthy onsite storage on the casks' integrity during transportation and on the effects of the large, heavy casks on the stability of the carrying vehicles, whether truck or railcar. The weight would not be a concern if barge transportation were used, but the increased turnaround time required for reusable casks by slower barge travel is an economic trade-off that must be considered.

OTA concludes that once the new casks for NWPA shipments have been developed, and have met NRC certification requirements, full-scale demonstration tests could assist in gaining a level of public confidence. So that their concerns are addressed, organizations and individuals critical of the current transportation procedures should be included in planning for a test. An extensive public information program would be important prior to the test to help affected Indian tribes, public officials, citizens, and safety and emergency personnel understand, to the degree possible, the technical background for the test.

However, considering the technical complexities of the issues, it is wise to be realistic about the extent to which a full-scale cask accident demonstration would increase public understanding. A well-planned, constructed, and staged full-scale demonstration could prove persuasive to many, but no accident demonstration can show all the possible events for all conceivable accidents.[44]

Currently, relations between and among Federal agencies, the nuclear container industry, the nuclear power industry, and State and local governments are strained, as the country struggles to come to grips with the need to dispose of nuclear wastes in a safe manner. The level of public apprehension about shipments of spent fuel requires carefully coordinated programs to address public concerns. Sensitivity to public concerns and programmatic coordination have heretofore not been outstanding at DOE, which will be responsible for NWPA shipments. The technical specifications for the shipping casks are difficult to explain and comprehend, and the stringency of the standards for ensuring spent fuel cask integrity is easily misunderstood. Industry and government will do well to address such apprehensions in a forthright manner. In the meantime, Congress might wish to require DOE to reduce one area of public concern by agreeing to begin using NRC-approved casks and notification procedures immediately for its unclassified shipments. **OTA finds that the parts of the nuclear waste transportation process most in need of change are the institutional attitudes of DOE and NRC and their interactions with the State and local governments and the general public. Comprehensive public information efforts are necessary to address concerns about the level of safety provided by Fed-**

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[43] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, *Annual Report to Congress*, DOE/RW-0004/2 (Washington, DC: March 1986), p. 23.

[44] U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on Nuclear Materials Packaging Technology," op. cit., p. 81.

eral regulations and cask specifications. Public participation, outreach, and information activities undertaken by the utilities that ship spent fuel regularly provide useful models for programs that DOE, as a future shipper, could develop.

State, local, and Indian tribal officials want to be full partners with the Federal Government in the NWPA transportation planning and decisionmaking process. In November 1985, DOE sponsored a workshop for State, tribal, and local officials to determine the extent and specific nature of their concerns about DOE's plans for shipments of spent fuel under NWPA. Such activities provide a forum for airing and moving toward resolution of conflicts. **OTA concludes that additional meetings, sponsored jointly by DOT, NRC, and DOE, in cooperation with public interest groups, such as the National Governors' Conference, the National Conference of State Legislatures, the International Conference of Mayors, and the National League of Cities, are essential to informing the public and improving intergovernmental coordination.**

Containers for Hazardous Materials

The packagings or containers used for shipping hazardous materials include tank trucks, railroad tank cars, and barges, as well as bottles, boxes, and drums. They are important factors in transportation safety. RSPA is responsible for issuing packaging and hazard communication regulations for all hazardous materials containers except bulk marine containers, which are regulated by the U.S. Coast Guard, and packaging for highly radioactive materials, for which regulations are developed by NRC.

DOT regulations apply to hazardous materials containers of all sizes, with requirements generally different, depending on whether the material is shipped in bulk or in small packages. DOT marks the dividing line between small (nonbulk) and bulk containers at 110 gallons or 1,000 pounds. Small packages of hazardous materials are carried by water, rail, highway, and air in approved packagings including drums, cylinders, boxes, cans, and bags. Bulk packages generally do not travel by air.

OTA's research shows that hazardous materials packaging generally has been adequately designed. Although there are some problem areas, industry often uses containers more sturdy than required by DOT regulations for very high-hazard materials.

Bulk Packaging

Because accidents and releases in any mode have a common source—human error—the safety records for bulk transport by the highway, water, and rail modes differ, according to the opportunities for error in each mode. Thus, more accidents, spills, injuries, deaths, and property damage occur on highways than on rail or water, in both absolute numbers and accidents per ton-mile traveled,[45] and more occur on rail than on water on a ton-mile basis, due to modal differences in the miles of network, number of operators and individual shipments, traffic densities, and average speed.

Other factors affecting safety include: the extent of coverage by and enforcement of Federal safety regulations for the vessel or vehicle; the amount and quality of training the vessel or vehicle operators and loaders receive; the frequency of maintenance and inspections of the vessel or vehicle; and finally, the coordination between the agencies responsible for regulation, inspection, and enforcement activities. Table 1-6 presents a comparison of modal characteristics for bulk shipping of hazardous materials.

Bulk equipment has a useful life of 20 to 30 years, although maintaining bulk vessels, tank cars, and trucks to high standards can become expensive after the first decade. Because of this long life span, there is little incentive for industry innovation. Changes to the regulations take years to implement, both because the industries involved are economically hard pressed and do not welcome potentially costly changeovers, and because at least two DOT agencies are involved in the decisionmaking process. In times of economic turmoil, such as the transportation industries are now undergoing, fleets may age and deteriorate.

Of the three modes of bulk hazardous materials transport, the highway mode is the most versatile and widely used, carrying over 55 percent of the an-

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[45] A ton-mile is the product of the tons of material carried and the distance carried in miles. For example, a truck with a load of 20 tons that traveled 100 miles would have logged 2,000 ton-miles. Ten trucks each carrying 2 tons and each traveling 100 miles would also have logged 2,000 ton-miles in the aggregate (each truck logging 200 ton-miles).

Table 1-6.—Modal Characteristics of Bulk Shipping of Hazardous Materials

	Highway	Rail	Water
Containers regulated by DOT[a]	Most	All	All
Inspection or testing frequency	Upon manufacture[b]	Upon manufacture plus every 5-10 years[c]	Yearly[d]
Commodity flow data[e]	Very little	Nearly complete	Complete
Regulators and inspectors[*]	RSPA, BMCS, NHTSA[f]	FRA, RSPA, AAR[g]	USCG, RSPA[h]
Fleet size	130,000 cargo tanks[i]	115,600 tank cars[j]	4,909 tank barges[k]
Fleet database[l]	Partial (BMCS)	Yes, complete (AAR)	Yes, complete (ACofE)
Number of operators[m]	260,000	26,000	45,000
Size of load (gals)	4,000-12,000	10,000-30,000	300,000-600,000

[*] See table 1-4 for numbers of inspectors.

[a] Federal regulations cover the transportation of hazardous materials by railcar, aircraft, vessel, and interstate transportation by motor vehicle. Intrastate highway transport of hazardous wastes, hazardous substances, and flammable cryogenics in portable tanks or cargo tanks is also covered (49 CFR 171.1). Unless a State has specifically brought intrastate commerce under regulation, containers in such service need not meet any standards. The Department of Transportation does not know the precise extent to which the States have extended the Federal regulations to intrastate commerce. Most gasoline transport by truck is intrastate and these shipments are a large percentage of the total hazardous materials shipments.

[b] Cargo tanks must undergo an external visual examination every 2 years but generally do not have to be leak tested or pressure tested. However, cargo tanks carrying chlorine must be pressure tested every 2 years and tanks carrying compressed gas (e.g., liquefied petroleum gas) must be pressure tested every 5 years; cargo tanks for flammable cryogenics are inspected prior to each loading. Most tanks, however, are not leak or pressure tested after they are built unless they have been out of service for a year or more, had repairs or modifications performed on them, are operating under an exemption to the regulations, or are used in an area of nonattainment of Clean Air Act standards for ozone. (49 CFR 177.824.)

[c] Tank cars carrying some cargoes are tested more frequently. For example, tank cars carrying chlorine must be tested every 2 years. Also, the frequency of inspection of some tank cars increases to once per year after they are 22 years old. General American Transportation Corp., *GATX Tank Car Manual, 4th Edition* (Chicago, IL: 1979).

[d] 46 CFR 31.10-15, and 31.10-17.

[e] Data on the identity and amount of hazardous materials shipped over the highways is collected by the Bureau of the Census every 6 to 7 years, however the quality and comprehensiveness of the data is poor. Records of 80 percent of all rail traffic are kept by the Association of American Railroads (AAR). A record of 1 to 6 percent of all rail traffic is kept by the Interstate Commerce Commission. Records of all origins and destinations of hazardous material cargo that travel on U.S. waterways are kept by the U.S. Army Corp of Engineers (ACofE).

[f] The Research and Special Programs Administration (RSPA) develops and publishes regulations on the cargo tanks. The Bureau of Motor Carrier Safety (BMCS) regulates in-use motor vehicles and drivers, and enforces regulations pertaining to the manufacture, marking, repair, etc., of cargo tanks. The National Highway Traffic Safety Administration (NHTSA) has responsibility for the original manufacture of the vehicle.

[g] AAR establishes the basic technical specifications for tank cars and their running gear. After public rulemaking and comment, RSPA adopts the final specifications in the regulations. Both AAR and the Federal Railroad Administration (FRA) inspect tank cars in rail service. Both AAR and FRA inspect tank manufacturers.

[h] For bulk vessels (tank ships and tank barges), the United States Coast Guard (USCG) establishes the regulations, performs the inspections, administers licenses, and specifies the design of vessels. RSPA sets the standards for intermodal portable tanks that can be carried on container ships and barges.

[i] Estimates from the 1977 Truck Inventory and Use Survey. Of these, 38,000 carry hazardous materials 25 to 49 percent of the time, 14,000 carry them 50 to 74 percent of the time, and 67,000 carry them 75 to 100 percent of the time.

[j] Written communication with AAR. This is about 60 percent of the total number of tank cars.

[k] American Waterways Operators. This is the number of inland tank barges, most of which carry hazardous materials. There are also a small number of ocean going barges and tankers that carry hazardous materials, but tank barges are responsible for most inland traffic.

[l] While the Army Corp of Engineers (ACofE) keeps track of the number of active and inactive vessels that may carry hazardous materials in U.S. commerce, and the AAR's UMLER file lists all tank cars by DOT specification that are in service, there is no comparable database for the highway mode. Although individual companies know how many and what types of cargo tanks or intermodal portable tanks they have, no single agency has an accounting of all bulk highway vehicles nationwide.

[m] "Operator" refers to the vehicle or vessel "driver." The number of people driving cargo tanks (carrying hazardous materials) is estimated by assuming there are two drivers per cargo tank. Large interstate private carriers often have three or more drivers per vehicle, while other carriers typically have fewer. Information on the rail mode was obtained from AAR and on the water mode from USCG. The number presented in the water mode represents all those licensed by USCG to operate commercial vessels; most of these would not routinely be involved with hazardous materials.

SOURCES: Unless otherwise indicated in footnotes, Office of Technology Assessment, based on information from participants of workshops and panel meetings or comments on draft reports.

Photo credit: American Bureau of Shipping

Inspections of vehicles and vessels can be performed by approval agencies recognized by DOT; the American Bureau of Shipping, Lloyds of London, and Bureau Veritas are among the largest of these.

nual total hazardous materials tonnage. (See table 1-1.) The nature of the bulk trucking business is different from that of the rail or water modes of bulk transport in that there are many more carriers of a wider variety, and many businesses are much smaller than those typically found in the rail or water mode. The carriers include private interstate carriers; large interstate common and contract carriers; and small common, contract, and private intrastate carriers.*

Tank trucks (or cargo tanks) are the main highway carriers of bulk hazardous materials. Usually made of steel or aluminum alloy, tank truck capacities range from about 2,000 to 9,000 gallons depending on the density, vapor pressure, and corrosiveness of the cargo. In some States, however, which allow higher gross weights, tank trucks may carry up to 13,000 gallons, sometimes in double tanks. Table 1-7 lists the main contemporary cargo tanks built to DOT specifications and examples of commodities each of them may carry. Older tank trucks built to outdated specifications may still be used to carry hazardous materials, but all newly constructed tank trucks must meet current specifications. These prescribe the thicknesses of the bodies of the tanks, pressure relief devices, manhole covers, gauging devices, overturn protection, pressure test methods, and the like.

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*Private carriers transport commodities that they own, and the transport is integral to their business. Common carriers are transporters of freight for compensation; common carriers must accept all traffic tendered to them that is within their operating authority (to the extent that they have equipment and drivers to do so). Contract carriers are transporters of freight by motor vehicle for compensation in the exclusive service to one or more specific shipper(s) as authorized by duly constituted Federal or State authority. This classification includes owner-operators under long-term lease to certified carriers.

Table 1-7.—Cargo Tank Table

Cargo tank specification number	Types of commodities carried	Examples
MC306	Combustible and flammable liquids of low vapor pressure	Fuel oil, gasoline
MC307	Flammable liquids, poison B materials with moderate vapor pressures	Toluene diisocyanate
MC312	Corrosives	Hydrochloric acid, caustic soda solution
MC331	Liquefied compressed gases	Chlorine, anhydrous ammonia, LPG
MC338	Refrigerated liquefied gases	Refrigerated liquid, oxygen, refrigerated liquid, methane

SOURCE: 49 CFR 172.101 and 178.315 to 178.343.

Turnover of equipment is slow, and cargo tanks generally go through several tiers of owners. Large private interstate carriers, often large petrochemical companies, have the resources to purchase new equipment and maintain it well. They use their trucks around the clock, 6 to 7 days a week and find it economical to retain tank trucks in their fleets for only 8 to 10 years. Maintenance costs to keep the vehicles up to their standards then become sufficiently high that they sell the trucks to a common carrier or to a jobber and buy new equipment.[46] In contrast, the average tank truck in the fleet of one of the country's two largest common carriers is now 12 years old, because economic competition is so fierce that, unable to afford major expenditures, companies are keeping their equipment longer. A second tier owner uses a tanker until it becomes uneconomical and then sells it to yet another owner. **This process continues despite the truck's inevitable deterioration, partly because Federal hazardous materials regulations do not generally apply to intrastate motor carrier transport.**[47]

OTA's analysis shows that cargo tank trucks transporting gasoline, about 49 percent of all hazardous materials transported by tank truck, are involved in accidents resulting in more deaths and damages than all other hazardous materials accidents combined. Trucks carrying chemicals represent about 20 percent of tank truck transport of hazardous materials. Of the chemicals, corrosive cargos have the highest accidental release rate per ton-mile[48] and exert the greatest wear and tear on tank trucks. In fact, one safety director told OTA that his acid tanks were ". . . junk after 4 years."

Problems with all varieties of cargo tanks have been studied by DOT over the past 10 years. Study results show that many of the releases from cargo tanks come from discharge valves, pressure relief valves, and manhole covers, and that poor maintenance and inspection of the tanks contribute to the problems. Many parts of a rulemaking proposed by DOT in September 1985 address these shortcomings.[49] **OTA finds that adoption of the proposed changes calling for stringent and more specific manufacturing standards, annual leak testing of all cargo tanks, and stronger manhole covers on gasoline tankers, will improve the performance of cargo tanks.** These actions, while not calling for significant redesign, nonetheless directly address many of the inadequacies uncovered in the DOT studies.

Moreover, if registration were required at the time of manufacture of each tank truck built to hazardous materials specifications, subsequent inspections could provide a means of identifying and tracking equipment design and maintenance problems. Release and accident data for the highway mode would be more useful if information regarding container type and primary commodity carried were acquired at the time of registration. Such records are currently kept for bulk marine vessels and railroad tank cars.

Since the early 1980s, when railcars carrying certain hazardous materials began to be equipped with shelf couplers, thermal insulation, and head shields, no catastrophic hazardous materials rail accident has occurred, although there have been numerous accidents and releases. OTA's data analysis shows that corrosives have the highest accident and release rate for commodities carried by rail. Many corrosives such as sulfuric acid and caustic soda are carried in tank car type 111A—the tank car type appearing most frequently in the HMIS. OTA concludes that research to address this issue is important. OTA did not make a detailed study of bulk marine vessels, and the data analysis did not indicate technical problems with bulk marine vessels warranting urgent attention.

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[46] Clifford Harvison, National Tank Truck Carriers, and E.E. Eigenschenk, Shell Oil Co., personal communications, 1985.

[47] Hazardous wastes, hazardous substances, and flammable cryogenics, and nuclear materials regulated by the Nuclear Regulatory Commission, are the only hazardous materials regulated by the Federal Government regardless of whether the commerce is intrastate or interstate, see 49 U.S.C. 173.

[48] Abkowitz and List, op. cit.

[49] "Notice of Proposed Rulemaking, Requirements for Cargo Tanks," *Federal Register*, U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau, Sept. 17, 1985.

OTA finds that countermeasures to address nontechnical issues are important for all modes. Special operator training specifically related to hazardous materials, and training for shipper and carrier personnel responsible for loading and unloading, fastening, blocking, and bracing nonbulk loads, could increase safety substantially. **Congress might consider mandating the development of specific training guidelines, through a consensus process utilizing shippers, carriers, and freight forwarders, as well as government safety personnel, to take advantage of existing expertise and resources.**

Intermodal Containers

Intermodal (IM) tanks are metal containers that hold 4,000 to 6,000 gallons and are surrounded by a metal protective frame that can lock into special fittings on a truck chassis, a railcar, or in a ship's hold or airplane cargo bay. They are versatile and efficient containers for substances that must travel long distances by several different modes. The United States has very few manufacturers of IM tanks, but rapidly growing numbers of these tanks are being transported into and around this country, often over three different modes in a single trip, as international trade increases. The tanks must be registered by serial number with DOT, but regulatory responsibility for them and their carrying vehicles is shared between RSPA and the modal administrations. The poor interagency coordination at DOT is a particularly acute problem for adequate regulation of the transport of these vessels.

The specific areas of concern are the types of chassis used and the method(s) of securing IM tanks onto truck chassis. DOT regulations permit securing the frame of an IM tank to a flatbed truck chassis with chains and hooks called J hooks—a fastening method of questionable reliability, as accident records are beginning to document.

Few appropriate truck chassis for intermodal tank containers are available in the United States. Most of the chassis available in this country are deficient either in length, securement devices, or overall design, which typically incorporates a high center of gravity. Loaded portable tanks must be carried on 40-foot chassis in order to comply with bridge laws that limit the vehicle weight per axle and per wheelbase. However, only about 400 40-foot chassis in this country have twist locks that positively secure the portable tank to the center of the chassis, preventing lateral or vertical motion, although there are several thousand portable tanks available for commercial use.[50] Thus, most intermodal tank containers now travel by highway on 40-foot flatbed trucks secured by chains, or on 20-foot chassis, which often have proper securement devices, but which violate road weight laws.[51]

In addition, few chassis are specifically designed for intermodal tanks. A "low-boy" chassis, with a centered flatbed several feet lower than normal, lowers the center of gravity and makes the vehicle more stable. Such chassis are used throughout Europe, but there are fewer than 100 in the United States. **OTA finds that immediate and intensive study of the motor vehicle chassis and securement methods for intermodal portable tanks is urgently needed.** The research should be conducted jointly by RSPA, BMCS, and FRA. Congress might wish to require that intermodal tanks travel only on chassis that have twist locks that positively secure the tank against vertical or lateral motion as an interim step.

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[50] George Graham, President, Chemical Leaman Container Corp., agents for Sea Containers Inc., personal communication, October 1985.

[51] George Graham, President, Chemical Leaman Container Corp., agents for Sea Containers Inc., a major owner, leaser, and transporter of intermodal containers, has strongly advocated that intermodal tanks not be allowed to travel on flatbed trailers secured only by chains. Chains or chain binders allow for tank movement and make the vehicle dangerously unstable. His comments were made at the first semiannual meeting of the Hazardous Materials Advisory Council, held at Hilton Head Island, SC, Nov. 14, 1985, and reported by Laurie Bradford in "Inexperience Poses Major Threat to Safety in Transport of 'HM,'" *Traffic World*, Nov. 25, 1985.

Small Packaging

Because of the limited amounts of hazardous material contained in small packages, releases generally do not have serious consequences. Release reports for small packages indicate that accidents occur more frequently through mishandling or misuse of the packaging, rather than because of container failure. Air carriers and the U.S. Postal Service reported to OTA that many problems arise from unwitting violations of regulations and mispackaged hazardous materials.[52] **OTA finds that stepping up public information programs and industry compliance training could improve safety.**

Accident and release data are so incomplete that thorough evaluation of the safety record of individual small package designs is impossible. Furthermore, the regulations that govern the packages are lengthy and complex, difficult to understand and follow, and out of harmony with those of our international trading partners.

Performance standards, already in international use for small packages, are likely to be adopted by DOT within the next few years, and the prospective changeover has been widely supported by most of the affected parties. **OTA finds that the new system will simplify the regulations making compliance with them easier, bring U.S. regulations into greater conformity with those of our international trading partners, and make packaging innovations easier and faster to evaluate and implement.** Adoption of performance standards should reduce the time required for the relatively small RSPA staff to handle exemption applications and free them for other functions such as data and trend analysis and planning.

OTA concludes that collection of release data for small packages needs to be improved and continued, so that packaging deficiencies can be identified and remedied, and the adequacy of the performance tests can be evaluated.

Defining Roles and Coordinating Programs

Federal agencies with overlapping interests and responsibilities need to coordinate common activities and define transportation-related policies more explicitly. OTA has identified several areas where specific action would increase effectiveness.

Public concerns related to shipments of spent nuclear fuel are focusing on transportation procedures and safeguards in addition to the containers for spent fuel. Congress might consider requiring DOE, NRC, and DOT to work out notification, State container inspection and other operating procedures, routing, and safeguard policies for NWPA shipments in consultation with each other and in conjunction with State and local officials. **While DOT and NRC both have regulatory roles and DOE is an operating agency, the policies and activities of all three agencies have a single impact on public perceptions.** Moreover, DOT, DOE, and NRC might consider undertaking a joint public information program, using staff specially trained in discussing technical matters with audiences that have widely varying values.

OTA also found that interprogram coordination within DOE has been sadly lacking, although recently, efforts have been made to improve the situation. Staff in offices such as emergency response and transportation often did not know each other and were not familiar with each other's programs. Continued lack of coordination will hamper implementation of NWPA activities and any interagency cooperative efforts.

Finally, Congress could take steps to promote improved coordination within DOT and among Federal agencies. A standing coordinating committee, perhaps under the umbrella of the National Response Team, could be established with representatives from each DOT modal administration, RSPA, other Federal agencies such as EPA, NRC, DOE, and FEMA, State and local governments, and industry. This committee might be required to meet periodically to: define Federal agency missions and roles in the transportation of hazardous materials, coordinate Federal training programs, oversee the development of national guidelines (described above), set a regulatory agenda for intragency and interagency issues, and oversee the coordination of common activities such as data collection and enforcement.

Subgroups could be formed to address areas of particular concern. More specifically, DOT and EPA could be directed to develop a joint program to educate small businesses that generate and transport hazardous wastes about DOT transportation requirements and the compatibility of wastes and containers. With more than 60,000 small-quantity generators of hazardous wastes becoming subject to EPA and DOT regulations, the potential for confusion and use of inappropriate containers is immense.

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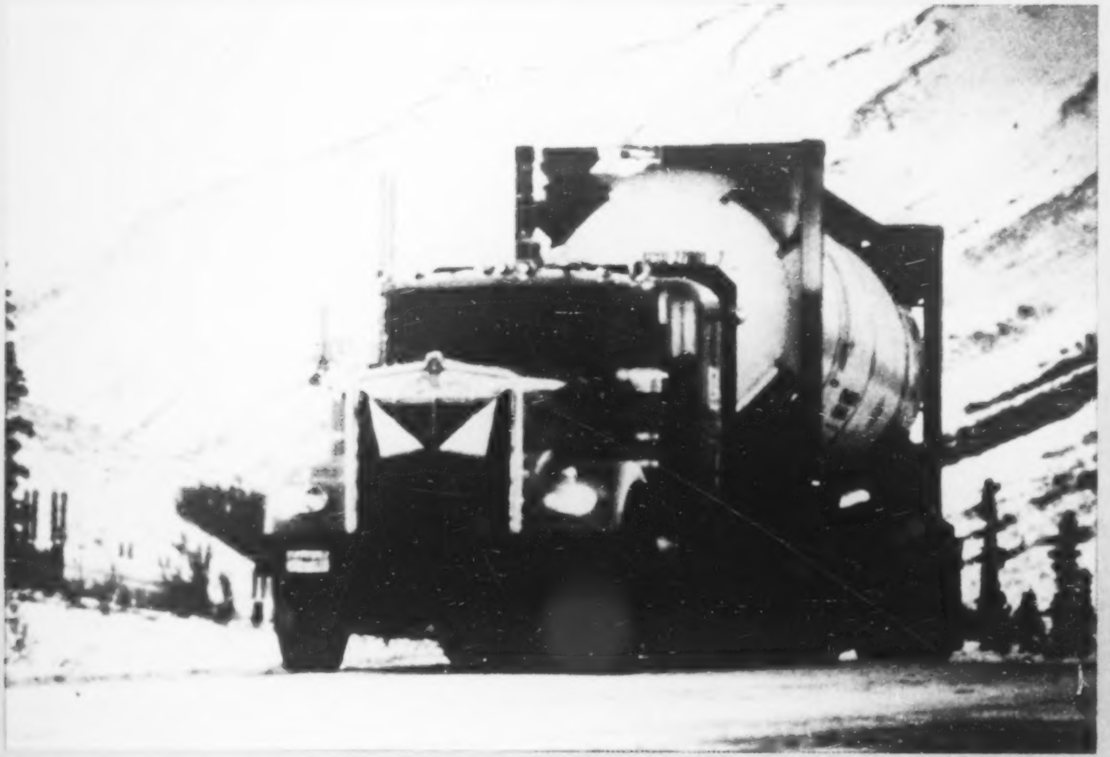
[52] Steve Gordon, U.S. Postal Service, personal communication, 1986.

Within DOT, intermodal agency groups could coordinate far more closely. RSPA could take a more aggressive role as DOT hazardous materials coordinator for research and data-collection programs, leaving modal operational details to modal administrations. Federal research on IM tanks is being done separately by modal administrations, when it is being done at all. FRA, for example, is conducting research on the dimensions of intermodal tanks on trailers and flatcars using truck chassis that violate over-the-road use in most States. Coordination for multimodal research is essential if the work is to be cost-effective. RSPA could act more effectively as coordinator between the Federal Highway Administration, BMCS, and FRA for this effort, to ensure that research results have practical value.

Chapter 2

Data and Information Systems for Hazardous Materials Transportation



Source: National Transportation Safety Board

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Chapter 2

Data and Information Systems for Hazardous Materials Transportation

Government agencies responsible for the transportation of hazardous materials need data about manufacturers, shippers, carriers, commodity flow, and accidents to help them set regulations, plan for accident prevention and emergency response, and target enforcement efforts. The U.S. Department of Transportation (DOT) has lead Federal responsibility for the transportation of hazardous materials, and many related databases are kept by the various administrations within DOT.

Over the last 10 to 15 years the public has become increasingly aware of the special environmental and public health damage that hazardous materials transportation accidents can cause. With this awareness has come an understanding by State and local officials that, while they have responsibility for public safety in their jurisdictions, they do not fully understand the local risk from the transportation of hazardous materials. Moreover, there is a pervasive feeling that Federal regulations and programs do not take special local circumstances into account and, in any case, may not provide an appropriate and acceptable level of safety. These jurisdictions require data about hazardous materials transportation in their areas to help them establish regulatory, enforcement, and emergency response programs that meet their needs.

The level of public knowledge about the amount and destinations of hazardous materials traveling in or near a jurisdiction is generally low, so it is difficult for policymakers to assess risks for their area.* Once officials realize this, often after a severe hazardous materials emergency for which the jurisdiction found itself ill-prepared, they begin to look for information. For example, a 1979 chemical plant fire in downtown Memphis prompted the mayor to initiate a planning and data-collection effort.

Photo credit: National Transportation Safety Board

Information gathered by State and local officials about commodity movements has been helpful in assessing risks and developing routing requirements.

However, acquiring necessary data is not easy. Such data as exist about facilities housing hazardous materials usually reside in fire departments or building permit files and are local in nature. For information on through shipments, the first step taken by a State or local jurisdiction is usually to seek assistance from Federal data sources. Yet, data and information pertaining to different aspects of hazardous materials transportation are kept by eight Federal agencies (see tables 2-1 and 2-10). The data systems are not interactive and do not use common commodity codes to identify the different hazardous materials. Furthermore, no Federal agency has a mandate to compare all the data or to analyze them for a comprehensive look at hazardous materials transportation patterns, although such information would be useful to Federal agencies in establishing program priorities.

Once they have determined that Federal resources are not helpful, some States and local jurisdictions have undertaken their own studies. After deciding what types of information will be most useful, they can tailor their efforts to meet specific needs. In many cases, demands for better Federal data have been voiced.[1] The increasing interest in better in-

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*For example, hazardous wastes and radioactive materials represent only about 1 and 2 percent respectively of the hazardous materials shipped annually. The health and environmental risks they present may be matched or exceeded by those of many other commodities shipped routinely, yet these two substances are most frequently the subject of State and local restrictions.

[1] The National League of Cities requested formulation of a Federal database on hazardous materials commodity flow as part of its 1985 transportation policy position.

Table 2-1.—Commodity Flow Databases

Databases	Kept by	Years	Modes	Commodity codes	Conversion table	Strengths	Weakness/drawbacks
Federal: Commodity Transportation Survey (CTS)	Bureau of the Census	1977	All	5-digit STCC	Yes	• Multimodal • Consistent selection procedure for all sample data points for all modes • Cross-checked against the census of manufacturers	• Only 5-digit level of commodities • No hazardous materials flags • Only shipments from manufacturing sites to first destinations • Only "principal" mode is reported
Truck Inventory and Use Survey	Bureau of the Census	1977, 1982	Highway	Simple classes	No	• Covers all trucks used in the United States • Contains hazardous materials-related data items • Sample biased toward heavy trucks	• No flow data • Only rudimentary commodity information • Tractor database, not a trailer database—reflects tractor use, not trailer use
Motor Carrier Census	Bureau of Motor Carrier Safety, FHWA	Most recent 5 years	Highway	Hazard classes	No	• Comprehensive listing of carriers and truck fleet operators	• No flow data • Mileage and fleet size data are sparse
Radioactive Materials Routing Report	Office of Hazardous Materials Transportation	1982 to present	Highway	Not applicable		• Almost complete flow data for highway route controlled quantities of radioactive materials • Gives highway route data	• Data is often not recorded for months after shipment • Material description not always complete
Waybill File	Interstate Commerce Commission	At least past 12 years	Rail, TOFC/COFC	7-digit STCC	Yes	• Well-organized sample (1%) of all rail flows • Database is consistent enough to allow trend analyses • Contains some routing information	• Not all hazardous material flows use the special hazardous materials STCC
Waterborne Commodity Statistics	Army Corps of Engineers	At least 12 years	Water, domestic and international	4-digit WCSC code	Only to a limited extent	• "100%" sample of all vessel movements • Complete routing information	• Only 163 commodity codes in all, so level of detail is weak • Conversion table has some incorrect cross-references
States: Hazardous Waste Shipment Data	States, for the EPA	Varies	Primarily highway	Either EPA codes or OHMT	No	• "100%" sample of all hazardous waste shipments • Actual flow data	• Many States do not computerize the data • No consistency to commodity code usage • No routing information
Private: TRANSEARCH, FREIGHTSCAN, etc.	Consulting firms	Varies	All	Varies, up to 7-digit for rail	Yes	• Cross-checked against other production/consumption data • Melding of the best available for each mode	• Truck flows predominantly based on the CTS data (see above)
TRAIN II	Association of American Railroads	Current	Rail, TOFC/COFC	7-digit STCC	Yes	• "100%" data on all movements for participating railroads • Routing information	• Not specifically designed to record car movement histories • Not in the public domain
National Motor Truck Data Base	Consulting firms	1977 to present	Highway	Varies, up to 7-digit STCC	Yes, where commodity code is provided	• Focuses on long-distance highway flows • True flow data • Describes the vehicle used to carry the commodity	• Purposely excludes short-haul truck movements, especially in the Northeast • Not in the public domain

ACRONYMS: EPA = Environmental Protection Agency; FHWA = Federal Highway Administration; OHMT = Office of Hazardous Materials Transportation, Research and Special Programs Administration; STCC = Standard Transportation Commodity Code; TOFC/COFC = trailer on flatcar (piggyback)/container on flatcar; WCSC = Waterborne Commerce Statistics Center (Army Corps of Engineers).

SOURCE: Office of Technology Assessment.

formation on movements of hazardous materials and more complete and reliable data on accidents and releases led Congress to identify an analysis of available Federal data and information resources as a specific focus for this Office of Technology Assessment (OTA) report.

By law, DOT is required to report annually on the safety of hazardous materials transportation, including:

1. a thorough statistical compilation of any accidents and casualties involving the transportation of hazardous materials, and
2. an evaluation of the effectiveness of enforcement activities and the degree of voluntary compliance with applicable regulations.[2]

To be responsive to this requirement and prepare an accurate report, DOT would need a comprehensive record of accidents and spills related to hazardous materials and some idea of how much hazardous material is transported annually by each mode. OTA research shows that, in fact, DOT has an incomplete record of accidents and spills and has no documentable idea of how much hazardous material is transported. Moreover, Research and Special Programs Administration (RSPA) officials told OTA that data collection was a secondary function, despite its importance to safety and risk analysis.

Furthermore, because DOT has made no ongoing effort to study hazardous commodity flow, it cannot reliably determine accident rates for various commodities or the containers in which they are carried, or pinpoint high-accident locations or special circumstances. Without sufficient data and accident analysis, DOT cannot plan adequately or set priorities for changing container and vehicle regulations to address risks and problems or evaluate technology advances. For a general discussion of the nature of risk assessment, see box 2A.

With OTA assistance, a contractor collected and studied relevant databases and other information currently kept by a number of Federal agencies. To check the Federal sources for accuracy and completeness, OTA looked for outside resources; States, local jurisdictions, and industries provided helpful data.

Box 2A.—Risk Assessment

Risk assessment involves estimating the frequencies and consequences of undesirable events, then evaluating the associated risk in quantitative terms. The process of risk assessment serves to organize thinking about risks, permitting the judgments of interdisciplinary teams of experts to be integrated in a systematic way. It also helps identify risks that might not have been thought of otherwise and it motivates improvements in data collection by pointing out database deficiencies. The results of risk assessment provide knowledge essential to informed decisionmaking.

Public concern is greatest about risks that are involuntary, uncontrolled, unfamiliar, immediate manmade, and catastrophic.[1] Hazardous materials transportation possesses many and sometimes all of these attributes. Risk assessments can help to address two fundamental questions, one quantitative and objective and one qualitative and subjective: What is the level of risk? and What levels of risk are acceptable to the parties concerned? The first question is relatively readily addressed with adequate data and proper methodology, whereas the second question involves numerous judgments and often a great deal of discussion and negotiation, especially when large numbers of people and several governmental jurisdictions are involved. Professional risk assessment places heavy emphasis on quantitative results. Where policy issues are involved, however, and involuntary risks exist, such as those associated with the transportation of hazardous materials, qualitative judgments are important.

The question of risk acceptability is complicated further by the fact that some of the concerned parties may have risk perceptions that differ substantially from the actual risks. Risk equity, the appropriate distribution of risks among different members of society, is another complicating factor.

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[1] N.C. Rasmussen, "The Application of Probabilistic Risk Assessment Techniques to Energy Technologies," *Annual Review of Energy*, vol. 6, 1981, pp. 123-138.

This chapter includes the findings of the OTA contractor's exhaustive investigation of the current Federal collection and analysis of information on commodity flows, accidents, and spills associated with the transportation of hazardous materials.[3] In addition, State and local data-collection efforts were reviewed to determine what information was deemed useful and whether Federal data could provide a resource. An OTA workshop and numerous personal interviews also provided information. Part I of the chapter deals with commodity flow data and Part II with incidents or releases.* Part I focuses on the quantity and quality of commodity flow (movement) data currently available to:

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[2] 49 U.S.C. 1808(e) and 33 U.S.C. 173(C) (173.51-59).

[3] Mark Abkowitz and George List, "Hazardous Materials Transportation: Commodity Flow and Information Systems," OTA contractor report, January 1986. This report is available from OTA on request.

- identify existing Federal hazardous materials-related databases that provide information on hazardous materials movements, and investigate their potential use to develop geographic flow trends and to understand the relative importance of all modes of transport for different regions; and
- identify State and local data-collection efforts and evaluate the need for a standardized database on hazardous materials transportation movement.

Part II explores hazardous materials transport release and accident reporting requirements, information systems, and release and accident trends. Among the issues addressed are:

- the institutional background of release reporting and data collection;
- the completeness and adequacy of the present reporting systems, and ways to make them more useful; and
- statistical analyses of the frequency of releases and related causes and consequences.

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*The Research and Special Programs Administration refers to a release of a hazardous material during transportation as an incident. There is no agreement on the definition of an incident among the other groups collecting data. OTA will hereafter refer to releases rather than incidents.

PART I: HAZARDOUS MATERIALS FLOW DATABASES

Identifying hazardous material flow-related databases is a complex task. Flow, vehicle and vessel fleets, and travel network data must be considered for all four major freight modes—truck, rail, marine, and air.** Moreover, many diverse organizations maintain different pieces of relevant information; these organizations include Federal agencies, State and local governments, trade associations, carriers, shippers, and consulting firms.

National Data Resources

Several databases are needed to describe the flows for the hazardous materials transportation network. Table 2-1 shows the major sources of hazardous materials flow data and indicates the commodities and modes covered by each one. For example, the 1977 Commodity Transportation Survey (CTS), collected by the U.S. Bureau of the Census, provides ways to estimate market shares and shipment trends. However, it lacks shipment data on major hazardous cargoes—waste materials, agricultural products, and raw materials, such as crude petroleum and natural fertilizers. Moreover, it reflects only shipments from the point of manufacture to the first destination, often a warehouse, missing all subsequent movements in the distribution chain. There is no specific focus on hazardous materials, meaning analysis is limited by the data contained in the commodity flows themselves, and it is not always possible to determine what percentage of the shipments are hazardous. Data submission is voluntary, creating unknown biases due to nonreporting. The scope of the survey is heavily dependent on Federal budget priorities, and the questions asked are not consistent, making trend analyses difficult. Moreover, the Bureau collects data at 5-year intervals and typically takes 2 years to release the data. Recently, budget constraints have made heavy inroads on many of the Bureau's activities. Data from the 1983 CTS was scheduled to be released late in 1985; however, the Bureau decided not to release the results, because the data was faulty and inadequate for analysis. Because the transportation industries have changed dramatically since 1977, not having more recent data is a severe handicap.

Despite these problems, the CTS is the only national multimodal database available. Other organizations, such as State and local governments, do not collect similar information. They rely either on the CTS directly or on its interpretation and enhancement by consulting firms for their multimodal

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**This report does not consider pipelines which transport somewhat more than half of all hazardous materials.

flow information.* Consulting firms use the CTS, supplemented heavily with other modal sources, to improve the quality of the data.[4]

Separate, relatively complete databases are available for rail and marine transport. Because the sample waybill data collected by the Interstate Commerce Commission (ICC) has recently been increased to include about 6 percent of all shipments, it is adequate for determining rail flows. Additionally, although costly and difficult to obtain, the proprietary TRAIN II data, kept by the Association of American Railroads (AAR), provides much more complete information representing 100 percent data on at least 80 percent of the rail shipments.

The data for marine vessel movements are essentially complete, although the marine commodity classifications are very broad, making it difficult to determine what specific commodities are being transported. Only 163 identifying codes are provided, of which only 30 pertain to hazardous materials. Additionally, no computer indicator is provided to show that a specific flow involved a hazardous material.

The available data for truck and air shipments are much less helpful. The absence of better truck data is an enormous gap, since trucks carry the most hazardous materials tonnage in the largest number of vehicles, giving the highway mode the most widespread public impact. The CTS is helpful for truck movements, but in addition to the shortcomings mentioned earlier, it misses some major flows. Data from the Truck Inventory and Use Survey (TI&U), which is also collected by the Bureau of the Census; and the Motor Carrier Census, which is collected by the Federal Highway Administration's Bureau of Motor Carrier Safety (BMCS), provide some useful information. However, these sources give only truck and truck-mile data for hazardous materials movements, not graphic flow information. The only other independent resource is the National Motor Truck Database, a private sector initiative, which is limited by an intentional bias toward long-haul shipments and does not cover the Northeast.

The CTS is the only public database for air shipments, and its air flow data is incomplete, as OTA learned from checking other data. Using a hybrid developed from all data available, OTA estimated aggregate modal commodity flows as shown in table 2-2.

Specialized Databases

Hazardous Wastes.—U.S. Environmental Protection Agency (EPA) regulations require every hazardous waste shipment to have a manifest,[5] copies of which are submitted to the State and eventually to the EPA regional office. Thus, in theory, a complete hazardous waste flow database exists. In practice, however, the extent of computerization varies widely from one EPA region to another, and OTA did not find any complete flow records. Nevertheless, an outgrowth of the manifest requirement is that States generally have good information on waste movements and carriers. In some cases, the States are collecting and computerizing the data for EPA. Carriers also have fairly complete data, even though they are not actually responsible for preparing the manifests.

Radioactive Materials.—The data on radioactive shipments are also relatively complete. The U.S. Department of Energy (DOE) maintains a list of all high-level radioactive shipments, and it conducts surveys of the low-level radioactive shipments. One such survey was conducted in 1975,[6] and a second was recently completed.[7] DOT compiles data on completed highway shipments of radioactive materials. More than 1,000 shipments have been recorded since January 1982 in the Radioactive Materials Routing Report (RAMRT) from DOE, the U.S. Nuclear Regulatory Commission (NRC), and NRC-licensed shippers. However, the RAMRT data may not be recorded for as long as 1 year after a shipment is made, because regulations do not allow release of routing information until after the entire

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*Two examples are FREIGHTSCAN, marketed by Data Resources, Inc., Lexington, MA, and TRANSEARCH, marketed by Reebie Associates, Greenwich, CT.

[4] Data Resources, Inc., "FREIGHTSCAN Technical Documentation," prepared by the Transportation and Logistics Service, Lexington, MA, no date.

[5] U.S. Environmental Protection Agency, "Identification and Listing of Hazardous Waste," 40 CFR, Part 261, November 1984, pp. 345-378.

[6] J.L. Simmons, et al., Battelle Pacific Northwest Laboratories, *Survey of Radioactive Materials Shipments in the U.S.*, NUREG-0073 (Richland, WA: Sandia National Laboratories, 1976).

[7] Harold S. Javits, et al., *Transport of Radioactive Material in the United States*, SAND 84-7174 (Albuquerque, NM: Sandia National Laboratories, April 1985).

Table 2-2.—Estimated Transportation of Hazardous Materials by Mode in 1982

Mode	Number of vehicles/vessels used for hazardous materials	Tons transported	Ton-miles
Truck	337,000 dry freight or flat bed 130,000 cargo tanks	927 million	93.6 billion
Rail	115,600 tank cars	73 million	53 billion[a]
Waterborne	4,909 tanker barges	549 million	636.5 billion
Air	3,772 commercial planes	285 thousand	459 million
Total		1.5 billion	784 billion

[a] Technically 1983 data; 1982 data had too many errors to allow calculations.

SOURCE: OTA calculations based on Federal data augmented by other resources.

shipment is completed. Thus the data are useful primarily from a historical viewpoint.[8]

Data Analysis Issues

To derive useful information on flows for all commodities, OTA contractors had to address three issues before beginning data analysis:

1. What geographical regions should be used in reporting hazardous material flows?
2. What lists of codes should be used in selecting hazardous commodities from the databases?
3. What process should be used in assigning DOT hazard classes to the various commodity codes?

National data resources may not provide State or local flow data at the level of detail that is desired for planning or response. However, regional and State-to-State flow patterns can be obtained and provide helpful information. Figure 2-1 shows the nine regional areas used for this study. The regions correspond closely to those used by the Bureau of Economic Analysis in the U.S. Department of Commerce and to the economic regions of the Nation. They reflect the concentrations of chemical and petroleum production in the West South Central region and manufacturing in the South and Middle Atlantic regions.

Hazardous commodities are defined for this analysis as all commodities listed in 49 CFR, Section 172, including everything from virgin materials to radioactive materials and hazardous wastes. At least 11 hazardous materials commodity codes are used by the different Federal agencies. These include: the RSPA codes (used in DOT's Hazardous Materials Information System (HMIS) spill database); the EPA codes;[9] the United Nations/North American (UN/NA) codes;[10] the Standard Transportation Commodity Codes (STCC),[11] of which there are two versions, the standard codes and the "49" series codes specifically established for hazardous materials; the National Motor Freight Classifications (NMFC);[12] the Army Corps of Engineers codes (AE);[13] and several Bureau of the Census codes, the Transportation Commodity Codes for domestic shipments (1977 Census),[14] the Standard Industrial Classification (SIC) codes for the 1983 Census (technically speaking, the SIC codes are developed and maintained by the Bureau of Economic Analysis, Department of Commerce),[15] the Schedule A codes for imports, and the Schedule E codes for exports.

No two databases use the same identifying code numbers. For example:

- the railroad waybill file uses seven-digit STCCs, both 49-series and regular codes;

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[8] Charles E. Sell and Bradford W. Welles, Sandia National Laboratories, *An Assessment of the U.S. Department of Transportation's Radioactive Materials Routing Report* (Washington, DC: International Energy Associates Ltd., January 1986), pp. 22-23.

[9] U.S. Environmental Protection Agency, op. cit.

[10] U.S. Department of Transportation, Materials Transportation Bureau, "Hazardous Materials Tables and Hazardous Materials Communications Regulations," 49 CFR 172, pp. 69-336, November 1984.

[11] Interstate Commerce Commission, *Standard Transportation Commodity Code Tariff*, STCC 6001-M (Chicago, IL: Western Trunk Line Committee, Jan. 1, 1985).

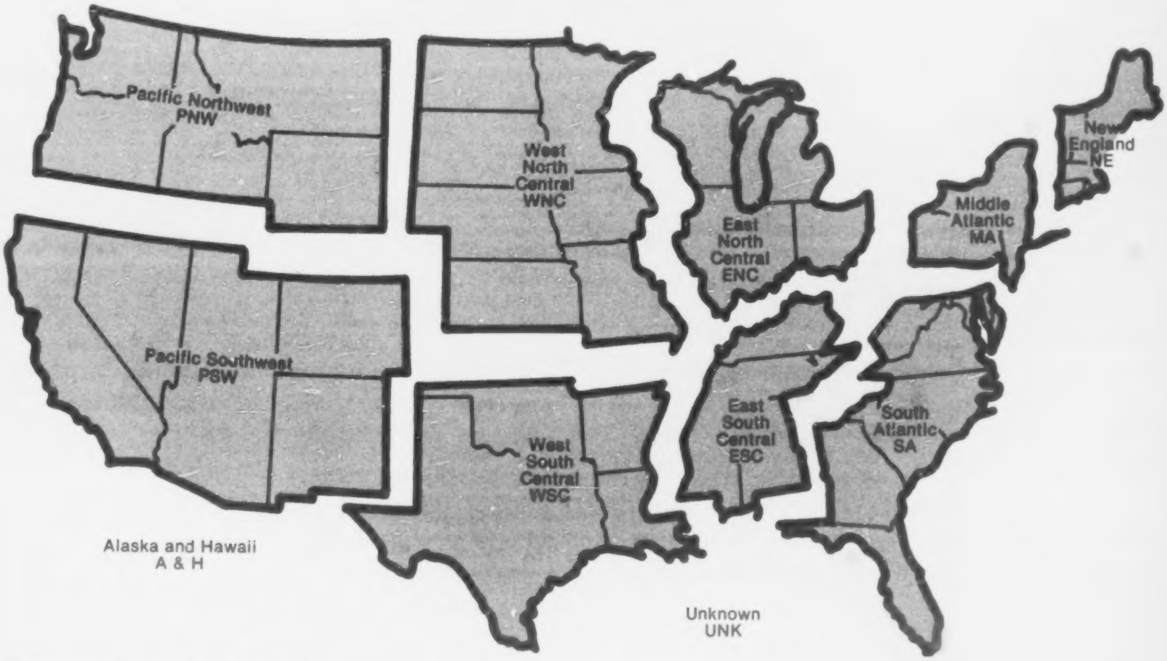
[12] Interstate Commerce Commission, *National Motor Freight Classification* (Washington, DC: American Trucking Association, May 18, 1985).

[13] U.S. Army Corps of Engineers, *Waterborne Commerce of the United States* (New Orleans, LA: Waterborne Commerce Statistics Center, 1984).

[14] U.S. Department of Commerce, Bureau of the Census, *Instructions for Completing the Commodity Transportation Survey, 1977 Census of Transportation*, Form TC-402 (Washington, DC: Sept. 20, 1977).

[15] U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business* (Washington, DC: U.S. Government Printing Office, monthly).

Figure 2-1.—Regions Used in This Analysis



SOURCE: Office of Technology Assessment.

- the CTS uses five-digit STCCs; and
- the waterborne commerce database uses four-digit Schedule A and Schedule E codes for imports and exports, respectively. See table 2-1 for a summary.

The codes are all used simultaneously, yet very few cross-reference tables have been developed. OTA contractors identified only five:

1. a conversion file between 49-Series STCCs, regular STCCs, and UN/NA codes maintained by AAR;[16]
2. a STCC to SIC conversion table at the four-digit SIC level maintained by AAR, which is in hard copy only;[17]
3. an NMFC to STCC conversion table maintained by the American Trucking Association (ATA);[18]
4. an Army Corps of Engineers' conversion file between AE commodity codes for water and the Bureau of the Census' Schedules A and E codes for imports and exports; and
5. a SIC, Schedule A, Tariff Schedules of the United States Annotated, and Schedule E translation file maintained by the Bureau of the Census.

The UN/NA numbers appear only once. **RSPA and EPA numbers do not appear on any conversion table**, a serious omission, as they are the two agencies charged most directly with responsibility for hazardous materials information.

Finally, hazardous commodity lists cannot be generated through computerized selection, making considerable preparatory analysis necessary to develop comparable data. For example, in the case of the Schedules A and E codes, a computer process generated a long list of nonhazardous commodities and missed two major hazardous commodities. For this study, as the database-specific commodity lists were developed, each commodity was given a hazard class distinction, so that spill rate statistics could be completed. RSPA has not identified hazard classes for any commodity list except its own, so suitable methods had to be developed to link hazard classes and commodities. This process was complex, and except for the 49-series STCCs, the hazard class assignments were not readily definable and required considerable judgment.

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[16] Association of American Railroads, *Price List of Publications* (Washington, DC: September 1983).

[17] Ibid.

[18] National Motor Freight Traffic Association, Inc., *STCC/NMFC Converter* (Washington, DC: June 14, 1971).

Truck Transport

Truck transport is the sector with the poorest data, yet it presents the most widespread public risk. Consequently, available data resources for this mode will be described in detail. Three principal national databases are available publicly to help analyze trucking flows: the 1977 CTS and the 1977 and 1982 TI&U. However, none presents a complete picture, nor were any designed to do so. The CTS provides origin-to-destination flow data on shipments from manufacturing plants to first destinations only, missing the rest of the distribution chain and all nonmanufactured goods.

TI&U provides a global picture of truck use, but lacks any origin to destination flow information or precise definition of commodities. The 1977 and 1982 TI&U surveys were both used for this report.

The 1977 TI&U contains information on each vehicle's registration and vehicle identification number; physical characteristics such as size, type of body, engine size, transmission type, and braking system; operator class (private, for-hire, owner-operator, etc.); range of operation (e.g., 50 to 200 miles); annual mileage; percentage of mileage in the home State; commodities carried (by percent of miles); and percentage of miles carrying hazardous materials. It is based on voluntary responses from the owners of the vehicles selected. It has no cross-checks except the State registration files from which the survey vehicles were selected. The 1982 TI&U contains data on the character and use of slightly over 90,000 trucks, a State-to-State sample drawn from an estimated universe of 35 million.

Supplementary information is available in the Motor Carrier Census, maintained by BMCS, which contains profiles of approximately 250,000 motor carriers. The database is used primarily to monitor carrier safety, and contains each carrier's State base of operations, the States served, the type of commodities carried and, for hazardous materials, the kind of container and tank or package used to carry commodities in each of the hazard classes designated by RSPA. Also, it contains information on the carrier's classification, such as: ICC common; ICC exempt; private; miles operated; number of drivers; and number of trucks, truck tractors, and trailers, segmented by type of ownership—owned, leased, or trip-leased.

The ICC Waybill Sample contains data on truck shipments that make use of rail for some portion of the move, such as piggyback or container on flatcar/truck on flatcar shipments.

Trade organizations generally do not keep flow data. ATA, for example, keeps only aggregate statistics on tons and ton-miles. Moreover, the firms submitting data are principally less-than-truckload carriers, so information about bulk shipments is lacking. Shipper organizations, like the American Petroleum Institute (API), the Chemical Manufacturers Association, the Petroleum Marketers Association, and the National Association of Chemical Distributors, are in much the same position as ATA.

Individual firms, however, do keep data on their own movements. Trucking firms generally keep computerized traffic databases that include origin, destination, commodity (by a variety of codes), shipment weight, and shipment date. Major shippers, like the large chemical and petroleum companies, also keep computerized data on their truck shipments. They record origin, destination, commodity (often on the basis of some marketing coding scheme), shipment weight, and shipment date.

Other types of data are kept by consulting firms, such as Transportation Research and Marketing, which has developed a National Motor Truck Data base (NMTDB).[19] Established to develop marketing information by AAR in 1977, NMTDB contains information on approximately 36,000 movements per year, some 4,000 of which involve hazardous materials. The data is collected at 18 selected truck stops, typically in the West and Midwest, to sample long-haul moves. The database includes origin city and State, destination city and State, commodity, vehicle characteristics, operator characteristics, and an operator profile. It is cross-checked to a limited extent against fuel sales at the truck stops and volume counts on selected Interstates.

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[19] Frances M. Larkin and K. Eric Wolfe, "Rail-Competitive Truck Characteristics, 1977-1982," unpublished typescript, 1983.

The TI&U shows that in 1982, 467,000 trucks were involved in carrying hazardous materials and collectively generated 1.6 billion truck-miles. This compares to 327,000 trucks and 1.3 billion truck-miles in the 1977 TI&U. The data show a 43 percent growth in the fleet size and a 23 percent growth in truck-miles compared to 1977 data, or 6 and 4 percent per year, respectively. The vehicles were predominantly either large, private tank trucks carrying petroleum and chemicals most of the time, or vans operated by for-hire carriers carrying hazardous materials less than 25 percent of the time. Mixed shipments were carried by 24 percent of the trucks and represented 35 percent of the truck-miles.

Trucks and Truck-Miles Based on the 1977 and 1982 TI&U Surveys

Table 2-3 shows the truck fleet breakdown for 1982. The comparable data for 1977 may be summarized as follows. Liquid tank trucks accounted for 30 percent of the fleet and 57 percent of the truck-miles. About 65 percent of the trucks had an operating range under 200 miles and accounted for 56 percent of the truck-miles. The trucks that operated over 200 miles accounted for 21 percent of the fleet and generated 40 percent of the truck-miles. Private carriers operated 78 percent of the trucks and generated 52 percent of the truck-miles. ICC common carriers were the second largest in size, at 12 percent of the fleet, and they generated 26 percent of the truck-miles. The common carrier trucks

Table 2-3.—1982 Truck Inventory and Use Survey Breakdown of the Hazardous Materials Fleet (467,000 trucks; 16,236 million truck-miles)

Statistic	Trucks (thousands)	Truck-Miles (millions)
Percent of miles involved in carrying hazardous materials:		
Below 25%	243.8	10,282
25-49%	117.0	2,971
50-74%	20.5	776
75-100%	80.3	2,191
Not reported	5.0	15
Body type:		
Van	140.8	7,016
Tank (liquid)	130.3	4,317
All other (28 categories)	195.5	4,903
Principal product:		
Mixed cargoes	113.5	5,716
Petroleum	136.6	3,491
Chemicals	60.3	2,069
All other (24 categories)	156.2	4,960
Gross weight (lbs):		
10,000 or less (2 categories)	122.5	1,818
19,501-33,000 (2 categories)	90.8	1,578
40,001-50,000	36.1	1,479
50,001-60,000	34.4	1,983
60,001-80,000	110.9	8,083
All other (8 categories)	71.9	1,295
Range of operation:		
Within 50 miles	269.7	4,888
50-200 miles	90.9	4,075
Over 200 miles	73.1	6,749
Off-road	32.3	525
Not reported	0.6	—
Operator class:		
Business use	275.8	6,200
Motor carrier	153.3	8,391
Owner/operator	21.1	1,423
All other (5 categories)	16.4	222

SOURCE: Office of Technology Assessment.

were driven 76,000 miles per truck per year, and the private trucks 22,000 miles.

The smaller trucks were used for local movements, while the larger ones dominated for operations over 200 miles. In fact, more than 85 percent of the "over 200 mile" truck-miles were in vehicles weighing 60,001 to 80,000 pounds. In addition, detectable populations of large trucks contributed to both fleet size and truck-miles in the under- and over-200 mile categories. The States with the largest fleets were Pennsylvania, California, and Ohio; those that had the most truck-miles were Ohio, Texas, and Pennsylvania.

Tons and Ton-Miles by Hazard Class

The two largest hazard classes transported by truck are flammable liquids and Poison B, regardless of whether measured by tons or ton-miles. Poison A, flammable compressed gas, and flammable solid are the next most important classes by tonnage; flammable solid, combustible liquid, and corrosive material are most important according to ton-miles.

The 1977 TI&U showed the truck-mile breakdown among commodities as 47 percent petroleum, 17 percent chemicals, and 36 percent "all other." In contrast, the CTS reported the ton-mile breakdown as 36 percent petroleum, 53 percent chemicals, and 11 percent "all other," thus clearly missing much of the petroleum flow. Furthermore, the CTS shows 65 million tons of petroleum being shipped by truck in 1977, whereas data supplied by API for 1984 indicates at least 105 million tons were delivered by truck. Petroleum consumption declined during the 7-year period. Moreover, the CTS shows no petroleum flow in the Southeast, one of the three largest flows in the API data.

Partial compensation for the missing petroleum flows can be made by assuming that all of the marine and pipeline shipments of gasoline, distillates, and kerosene are eventually made by truck. This assumption boosts the CTS tonnage estimate from 133 million tons to 566 million tons, or more than a fourfold increase. Region-to-region flow patterns based on this hybrid database are shown in table 2-4. Seventy-two percent of the flows are intraregional, led by shipments in the West South Central, East North Central, and Pacific Southwest regions. Classified by hazard class, the CTS data show flammable liquid is the largest class, whether measured in tons or ton-miles. The next largest category is Poison B, reflecting the chemical shipments. These statistics must be viewed as best estimates, however, because the completeness of the commodity flow data is questionable, and the specificity of the commodity definitions is limited.

Petroleum and gasoline shipments account for almost half of all truck transport of hazardous materials. To offset the lack of petroleum truck shipment data in the CTS, OTA requested assistance from the API Transportation Committee. API conducted a survey of oil companies that operate private truck fleets and received responses from nine of the largest companies. Each provided a profile of the distribution patterns at its terminals, broken down by type of product and type of delivery—whether by proprietary fleet or jobber.* Moreover, for the proprietary deliveries, they provided minimum, average, and maximum delivery distances.

The API survey covers 519 terminals, located in 45 of the 50 States, including Hawaii and the District of Columbia. The States with the most terminals are California with 31, Pennsylvania with 30, and Texas with 28. The survey showed shipments of 27 billion gallons of gasoline (over 25 percent of the national total); 1.0 billion gallons of diesel fuel (2 percent); 1.3 billion gallons of distillates (5 percent); and 0.8 billion gallons of other products, principally aviation gasoline, Jet A, and turbine fuel.

Among these, 44 percent of the gallons are delivered by jobbers. In fact, jobbers deliver 78 percent of petroleum products other than gasoline and 39 percent of the gasoline (see table 2-5). Hence, oil companies have only partial responsibility for highway movements of petroleum. The average delivery distance is short, at 28 miles, and distances do not differ markedly by geographic region—the maximum delivery distances are all less than 250 miles.

Chemicals represent the second largest category of hazardous materials transported by truck. The TI&U data show that 13 percent of the trucks carrying hazardous materials 75 to 100 percent of their miles were hauling chemicals and generated 17 per-

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*A jobber is an independent petroleum marketer, who buys a truckload of product from the petroleum company at the terminal and delivers it as a private marketer to his own customers.

Table 2-4.—Hazardous Commodity Flows by Truck According to the 1977 Five-Digit Commodity Transportation Survey Database[a]

All flows in thousands of tons: From ↓/To →	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Pacific Northwest	Pacific Southwest	Alaska & Hawaii	Unknown[b]	All
New England	13,863	136	36	202	26	20	28	7	35	0	0	14,353
Middle Atlantic	1,077	**63,020**	3,056	2,022	269	265	475	34	246	1	20	70,485
South Atlantic	238	949	**43,482**	766	474	226	167	3	114	1	342	46,772
East North Central	257	1,009	953	**110,434**	790	2,696	522	53	316	3	25	117,058
East South Central	132	341	787	587	9,251	282	352	11	158	0	7	11,908
West North Central	7	57	75	520	74	22,152	229	1,572	2,518	0	3	27,207
West South Central	58	729	803	1,006	3,651	573	**171,379**	63	840	0	1,222	180,324
Pacific Northwest	0	1	3	1	0	285	1	18,846	70	1	0	19,208
Alaska and Hawaii	—	—	—	—	—	—	—	—	—	3,146	—	3,146
Pacific Southwest	9	415	17	132	43	110	66	656	**73,244**	2	1,005	75,699
All	15,641	66,657	49,212	115,680	14,578	26,609	173,219	21,245	77,541	3,154	2,624	566,160

[a] It was assumed that all shipments of gasoline, distillates, and kerosene by marine and pipeline utilized truck for final delivery.

[b] Unknown includes Puerto Rico, Virgin Islands, other U.S. territories, and foreign.

Note: Boldface indicates top five flows, for example, **171,379**.

SOURCE: Office of Technology Assessment.

Table 2-5.—Gallons by Product Type Based on the American Petroleum Institute Survey of Producers With Large Proprietary Fleets (519 Terminals)

	Proprietary delivery			Jobber delivery	
Product	Number of terminals	Gallons (millions)	Average distance (miles)	Number of terminals	Gallons (millions)
Gasoline	349	16,544	28	424	10,588
Diesel fuel	66	251	39	81	830
Other distillates	88	486	32	160	959
Propane	0	0	—	71	469
Other			18		
Turbine fuel	2	75	—	5	37
Jet fuel	4	17	—	19	106
Aviation gasoline	0	0	—	1	615
All	349[a]	17,373	28	497[a]	13,604

[a] This is not a total of this column. Of the 519 terminals, 349 had proprietary delivery, and 497 had jobber delivery.

SOURCE: Office of Technology Assessment.

cent of the truck-miles. A State-to-State analysis of the CTS indicates 59.7 million tons of chemicals were moved by truck. About 60 percent of the chemical flow was intraregional led by the West South Central, South Atlantic, and Middle Atlantic regions with an average length of haul of 253 miles.

At OTA's request, several major chemical companies provided flow data on their 1983 and 1984 shipments of hazardous materials. Each of the databases included origin State, destination State, commodity, tons, and number of shipments. Combined, the firms encompass 5 percent of the tons for the flows shown in the State-to-State the CTS data. The private flow data agreed with the CTS on 8 of the 10 largest movements, although their rankings differ, indicating that the CTS may be a reasonable reflection of the major flows, although the actual volumes are questionable.

Railroads

Commodity flow analysis is the easiest for railroads. The ICC waybill database, while encompassing a 1 to 6 percent sample of all railcars, provides information on every movement of these cars, with the exception of detailed routing information. It is not possible to tell which of two or more possible tracks a car has traveled between origin and destination. The waybill shows origin and destination city and State, commodity (seven-digit STCC), number of cars, shipment weight, shipment cost rail revenue, and the railroad junctions traversed. It is based on carloads terminated by all the Class I carriers and some of the Class IIs and Class IIIs. Since AAR took responsibility for collecting the waybills and preparing the samples in 1983, numerous edits and cross-checks have been introduced, and the quality of the sample has improved.

AAR, the major rail trade organization, maintains a comprehensive database, TRAIN II, on the movements of about 80 percent of all railcars. Each railroad participating in TRAIN II submits location and status information on all the cars on its lines. Shippers, many of whom own their own railcars, and other railroads can determine daily where their cars are and their respective status. For each car, the database includes present location at an origin, destination, or intermediate point; empty/loaded status; and the commodity being carried (seven-digit STCC). AAR presently uses TRAIN II to develop summaries of hazardous material flows; it has prepared tables of carload originations and terminations by STCC for each State, as well as tables showing U.S. flows for all hazardous commodities, ranked by total carloadings.

Most railroads, and certainly the major ones, maintain traffic flow databases. A few keep times and locations for all events in the car movement cycle,[20] while most keep waybill data, such as shipper, consignee, online and offline origins and destinations, cars, tons, and revenue.

This analysis of hazardous materials transported by rail was based on the waybill files for the years 1972 to 1983, and examination of the 1977 CTS.

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[20] George F. List, et al., *Evaluation of MoPac's Freight Car Scheduling System*, FRA-ORRP-81-3 (Washington, DC: U.S. Department of Transportation, 1981).

Between 1972 and 1983, the total number of hazardous records in the waybill file grew from 11,388 to 15,687, a compounded increase of 3 percent a year. For 1983, the waybill file indicates 73 million tons of hazardous commodities were transported by rail, generating 53 billion ton-miles. Chemicals are the largest commodity group, constituting 68 percent of the tons and 66 percent of the ton-miles. Petroleum ranks second at 23 percent of tons and 20 percent of the ton-miles, followed by commodities in the "all other" category.

The largest hazard class was flammable liquids with 26 percent of the tonnage, followed by corrosive materials with 25 percent and flammable compressed gases with 12 percent. In conjunction with combustible liquids and nonflammable compressed gases, these five hazard classes account for 85 percent of the 1983 tonnage. Poisons and radioactive materials are small portions of the flows; radioactive materials are less than 0.03 percent, Poison B is less than 3 percent, and Poison A is less than 0.1 percent.

Origins and destinations are concentrated and the level of concentration is increasing. The waybill file shows a drop from 1,472 origin and 3,210 destination Standard Point Location Codes in 1972 to 1,129 and 2,410 in 1983, respectively. The 15 largest junction volumes are shown in table 2-6. Region-to-region flows appear in table 2-7. More than 25 percent of the flows originate in the West South Central region; more than 20 percent of them terminate there as well. The three largest flows are West South Central to West South Central, South Atlantic to South Atlantic, and West South Central to South Atlantic. The private chemical manufacturers data confirm these flow patterns, although there are some differences due to market share.

The primary car type is the tank car, accounting for 85 percent of the tons, 79 percent of the ton-miles, and 81 percent of the car loadings. At the end of 1984, the active tank car fleet numbered 183,000, of which 115,600 were used for hazardous materials. The majority of these were 111As, 112s, 103s, and 105As. Covered hopper cars ranked second in tonnage, carrying 6 percent; but intermodal flatcars ranked second in loadings and ton-miles, due to the large quantities of alcohol being shipped in trailers and intermodal portable tanks.

A breakdown of the hazardous tonnage by length of haul shows that the most tonnage travels between 0 to 250 miles, but the distribution extends beyond 4,000 miles, with an average length of haul at 728 miles.

Water Transport

Commodity flow analysis for the marine transport is straightforward but difficult. The U.S. Army Corps of Engineer's Waterborne Commerce Statistics Center (WCSC) database includes 100 percent of all commodity movements, both domestic and international, missing only military cargo moved in Department of Defense vessels. Information provided on each movement includes: origin district,

Table 2-6.—Fifteen Largest Junction Volumes, 1977 and 1983

1977		1983	
Junction	Tons (000)	Junction	Tons (000)
New Orleans	4,198	New Orleans	5,149
Chicago	4,008	East St. Louis	4,429
East St. Louis	3,509	Chicago	4,038
Kansas City	2,768	Shreveport	3,331
Shreveport	2,695	Kansas City	2,508
Memphis	2,183	Memphis	2,355
Chattahoochee	1,918	Cincinnatti	1,491
Atlanta	1,716	Richmond	1,092
Montgomery	1,603	Potomac Yard (Arlington, VA)	1,049
St. Louis	1,474	Effingham (GA)	830
Birmingham	1,414	St. Louis	773
Cincinnatti	1,379	Corsicana (TX)	770
Potomac Yard (Arlington, VA)	1,057	Mobile	702
Effingham (GA)	757	Fort Worth	675
El Paso	724	Dallas	663

SOURCE: Office of Technology Assessment.

Table 2-7.—Hazardous Commodity Flows by Rail According to the 1983 Waybill Statistics

All flows in thousands of tons: From ↓/To →	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Pacific Northwest	Pacific Southwest	All
New England	985	53	37	28	6	1	7	2	3	1,112
Middle Atlantic	681	1,710	542	827	110	103	495	10	54	4,532
South Atlantic	91	732	**5,842**	1,215	716	510	364	11	117	9,598
East North Central	319	1,470	820	2,527	610	735	629	83	220	7,413
East South Central	17	400	2,933	901	2,401	125	1,028	8	191	8,004
West North Central	23	95	110	991	349	1,739	642	102	245	4,296
West South Central	281	1,582	**4,266**	**3,370**	**3,577**	1,889	**10,626**	283	2,038	27,912
Pacific Northwest	—	66	16	174	11	423	106	1,551	488	2,835
Pacific Southwest	39	144	366	624	130	146	919	551	3,331	6,250
All	2,436	6,252	14,932	10,557	7,910	5,671	14,816	2,601	6,687	71,962

Note: Boldface indicates top five flows, for example, **10,626**.

SOURCE: Office of Technology Assessment.

port, dock, and date; destination district, port, dock, and date; commodity (four-digit code); shipment weight (short tons); operator; vessel description; and the waterways traversed, including entry and exit mileposts. It is based on data submitted by carriers, shippers, and vessel owners in response to comprehensive reporting requirements. However, two major information shortcomings create difficulties. First, the commodity definitions are very broad; only 30 out of a possible 163 codes pertain to hazardous materials. Second, while complete routing information exists, no mileage data are provided in the basic flow records, which means the mileage information for every flow must be computed and added to the database if ton-mile statistics are to be developed. Because of cost constraints, the OTA analysis did not develop ton-mile statistics.

Analysis of the WCSC data shows that a billion tons of cargo were shipped by marine transport in 1982. Hazardous commodity shipments constituted 55 percent of the total or 549 million tons. The flows are concentrated, as noted in table 2-8, with the 10 top region-to-region flows accounting for 65 percent of the total tonnage. Intraregional shipments in the West South Central region alone account for about 25 percent of the total tonnage. The pattern of flows follows the distribution of petroleum, since 85 percent of the hazardous tonnage is crude or processed petroleum.

From 1977 to 1982, the tonnage increased less than 4 percent; however, the commodity mix changed significantly. Chemical shipments dropped 13 percent and petroleum products dropped 22 percent, while the "all other" category doubled in size. More importantly, the mix of chemical products changed. Fertilizers rose to the second- and third-ranked positions displacing second-ranked sodium hydroxide and third-ranked benzene and toluene. Furthermore, this trend toward declining large bulk shipments of high hazard chemicals is likely to continue. Manufacturers are substantially reducing their inventories of raw materials in a variety of ways for both economic and safety reasons.[21]

Tankers and tanker barges are the principal vessels (91 percent); the other major vessel type is the dry cargo barge with 8 percent of the total. The five-digit CTS database captures only 40 percent of the flows and has a vastly different breakout of commodities. It misses the two major waterborne flows, crude oil and fertilizer, because they are not manufactured products.

Air Transport

Air transport has the weakest data for analyzing hazardous materials commodity flow. The only available database is the CTS, which, as previously noted, includes shipments from point of manufacture to first destination only. Federal Aviation Administration (FAA) inspectors sometimes perform 90-day records checks, but the only information they keep is the number of hazardous class shipments, not the overall percentage or the total volume.

The CTS indicates that 52,700 tons of hazardous materials were transported by air, or 8 percent of all air cargo tonnage. Chemicals account for 80 percent of this total, consisting of cosmetics, drugs,* and agricultural chemicals including fungicides and herbicides. As may be calculated from table 2-9, 79 percent of the tonnage, including the largest flow, is interregional, unlike the other transport modes. The average length of haul is over 1,000 miles. When the CTS data were compared with a private air carrier's records of its hazardous material flows, the inadequacy of the CTS information became apparent. The air carrier reported substantial hazardous materials shipment volumes for eight of the nine Pacific Northwest originating flows where the CTS showed no movement at all. One of these was the 12th largest region-to-region flow. Of the 72 remaining flows for other originating regions, there were 11 flows where the carrier's tonnage exceeded that shown in the CTS, and 3 more where the carrier's tonnage was nearly equal to the total shown by the CTS. Although the CTS data were for 1977 and the carrier's data for 1983 and 1984, they nonetheless demonstrate that the CTS data are not a useful reflection of hazardous material flows by air.

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[21] Monsanto Co., *One Year Later: Report of the Monsanto Product and Plant Safety Task Force* (Saint Louis, MO: December 1985); and Ron Jacobsen, Distribution Manager, Rohm & Haas, personal communication, January 1986.

*Because they contain small amounts of hazardous chemicals, cosmetics and drugs are regulated as hazardous materials.

Table 2-8.—Hazardous Commodity Flows by Water According to the 1982 Waterborne Commerce Statistics Center Database

All flows in millions of tons: From ↓/To →	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Pacific Northwest	Pacific Southwest	Alaska & Hawaii	Unknown[a]	All
New England	2.4	0.5	—	—	—	—	—	—	—	—	—	2.9
Middle Atlantic	20.9	**65.4**	3.6	0.3	0.2	—	2.2	—	—	—	0.6	93.2
South Atlantic	1.6	8.9	23.4	0.1	0.3	0.2	0.2	—	—	—	0.6	35.3
East North Central	—	1.8	1.2	9.4	3.4	2.3	3.4	—	—	—	—	21.6
East South Central	—	0.8	5.6	1.2	6.1	0.5	7.4	—	0.6	—	0.2	22.4
West North Central	—	0.1	—	2.7	1.4	0.8	3.8	—	—	—	—	8.9
West South Central	7.7	13.1	**24.5**	6.3	11.1	3.7	**75.0**	—	2.0	—	5.7	149.1
Pacific Northwest	—	—	—	—	—	—	—	16.9	2.4	0.8	—	20.1
Pacific Southwest	—	0.1	0.2	—	—	—	1.0	5.2	**31.0**	1.5	—	38.9
Alaska and Hawaii	—	—	—	—	—	—	0.7	18.0	**30.9**	6.1	38.7	94.4
Unknown[a]	0.7	15.2	5.4	—	2.1	—	30.7	—	0.5	—	7.9	62.4
All	33.3	105.9	63.9	20.0	24.6	7.5	124.4	40.1	67.4	8.4	53.7	549.2

[a] Unknown includes Puerto Rico, Virgin Islands, other U.S. territories, and foreign.

Note: Boldface indicates top five flows, for example, **75.0**.

SOURCE: Office of Technology Assessment.

Table 2-9.—Hazardous Commodity Flows by Air According to the 1977 Five-Digit Commodity Transportation Survey Database

All flows in thousands of tons: From ↓/To →	New England	Middle Atlantic	South Atlantic	East North Central	East South Central	West North Central	West South Central	Pacific Northwest	Pacific Southwest	Alaska & Hawaii	All
New England	—	0.2	—	0.5	0.1	—	—	—	0.1	—	0.9
Middle Atlantic	0.2	2.1	0.9	1.9	0.1	0.5	0.8	0.2	**3.9**	—	10.6
South Atlantic	0.1	—	0.3	0.1	0.5	0.4	0.1	—	0.3	—	1.8
East North Central	0.2	0.8	0.3	0.1	—	1.2	0.1	—	2.2	—	4.9
East South Central	—	—	0.1	—	—	—	**3.8**	—	0.3	—	4.2
West North Central	—	0.1	0.1	0.1	—	—	0.3	—	0.1	—	0.7
West South Central	—	—	—	—	—	0.1	**4.3**	—	0.1	—	4.5
Pacific Southwest	0.8	0.1	—	**18.1**	—	0.6	0.4	—	**4.4**	0.4	24.8
All	1.3	3.3	1.7	20.8	0.7	2.8	9.8	0.2	11.4	0.4	52.4

Note: Boldface indicates top five flows, for example, **18.1**

SOURCE: Office of Technology Assessment

State and Local Studies

OTA reviewed numerous State and local information-collection projects to determine whether a Federal data system would provide useful additional information. The research uncovered a variety of approaches to State and local data collection. When a State undertakes a study, a lead agency is usually designated, often the department of transportation or State Police, with assistance provided by an office of emergency preparedness or comparable agency. For cities, municipal planning staffs, fire departments, private consulting firms, or university-based research groups do most of the data gathering and analysis.

Techniques and results vary according to the particular interests, resources, and experience of the agencies involved. Nonetheless, OTA has identified types of useful data, effective methods, and commonly encountered problems. The following kinds of studies can provide the background information necessary for planning and emergency preparedness:

- **Inventory of hazardous materials stored at fixed facilities.** Records the quantity and type of hazardous commodities stored in manufacturing, wholesaling, distribution, or storage facilities within the jurisdiction. Data are obtained by means of questionnaires, interviews, and inspections; and from public records, such as fire inspection records and business tax records.
- **Hazardous materials transportation analysis.** Identifies the quantity and type of hazardous materials transported through the jurisdiction by each transportation mode and the most frequently used routes. Data are gathered by questionnaires, roadside inspections, and review of company records.
- **Hazard assessment or identification of hazards and high-risk locations.** Analyzes factors such as population density, transportation system characteristics, and past incidents to determine where the risk of a hazardous materials incident is greatest or where the impact would be the most severe.

An inventory of fixed facilities is often the first step in the data-gathering process. Any second step is usually a transportation analysis. A hazard assessment is frequently last, since it draws on data collected in the first two studies.

Fixed Facilities Inventories

Knowledge of the extent and nature of hazardous materials manufacture and storage in the community is essential for prevention and response planning. A facilities inventory can guide the purchase of equipment, choice of training, location of response facilities, and assignment of personnel, and can provide a good indication of the hazardous materials transported in the jurisdiction.

One of the first decisions necessary in undertaking a hazardous materials inventory is what should be inventoried and in what detail. Some jurisdictions studied by OTA chose to locate all hazardous materials, including paint thinner stored in retail stores, but most concentrated on chemicals manufactured or stored in bulk. Memphis, for example, limited its inventory to 255 manufacturing sites.[22] At the other extreme, the cities of Santa Clara County, California, inventoried all materials identified by DOT as hazardous and stored in any quantity at commercial facilities, including drug stores;[23] the inventory is kept current by the county. The majority of communities, however, have limited their surveys to selected commodities identified by the staff and advisory committees and to major facilities, measured by employment levels.[24]

The methods used for collecting data vary. In Memphis and Indianapolis, the initial data-collection method was a questionnaire. Questionnaires sent under the auspices of the Memphis Fire Department asked for data on storage of material in 19 DOT hazard classes. Although followup to the questionnaire was a lengthy process, the city currently has information on the type, quantity, and location of stored hazardous materials, including site plans and names, addresses, and phone numbers of emergency contacts.[25] In Indianapolis, only 20 to 25 percent of the 1,200 local industries surveyed submitted responses to the questionnaire and extensive followup was necessary to collect sufficient data. The Association of Bay Area Governments, around San Francisco, identified target commodities but did not have the budget or personnel to administer questionnaires. Instead, Bay Area planners produced a series of small maps, showing the locations of manufacturing firms that frequently used the selected group of hazardous materials, anticipating that each county would eventually survey individual firms.[26]

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[22] National Conference of State Legislatures, *Hazardous Materials Transportation Regional Workshops* (Denver, CO: 1983), p. 65.

[23] Cambridge Systematics, Inc., *Community Teamwork—Working Together To Promote Hazardous Materials Transportation Safety* (Washington, DC: U.S. Department of Transportation, 1983), p. 6.

[24] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, February 1986), ch. 4.

[25] National Conference of State Legislatures, op. cit.

Santa Clara County collects information by means of a regulatory procedure, which also finances the hazardous materials control program. To obtain a business license, all firms selling, using, or producing hazardous materials must provide local officials with an inventory and pay a fee based on the amount of materials stored. The fees help support the county's emergency response team and hazardous materials inspections. Local manufacturers and merchants are advised on the proper storage and handling of hazardous materials during these inspections.

Inventories can provide information for many purposes in addition to planning. In Oregon, the Multnomah County Fire Department collects information on hazardous materials storage at fixed facilities as part of routine fire inspections. The county's Office of Emergency Management stores the information in a computer along with data on chemical characteristics of the commodities, transportation routes frequently used, and performance profiles of major carriers. The county's specialized hazardous materials team has access to this database through a computer terminal located in the response vehicle. The computer system can provide information on where a specified product can be found at the site, how it is stored, and other chemicals that may be present. The system also provides information on the characteristics of all the chemicals known to be in the county, based on DOT and other standard classifications, and the names of organizations to call for additional product information.[27]

State Inventory Studies

Massachusetts is one of the few States that has completed a fixed facilities inventory. For each of the State's 14 fire districts, State analysts used manufacturing directories to locate the firms with more than 100 employees that used or produced hazardous materials.[28]

In March 1983, the State of New Jersey passed a law requiring every firm manufacturing or handling hazardous substances to file a completed survey form with the State Department of Health and the county or local health, fire, and police departments. This information effectively provides a facilities inventory.

The State of Maryland has created a computerized registry of all toxic and carcinogenic substances stored at fixed sites. The State Department of Health and Mental Hygiene began gathering the data in 1979 with funds from an EPA grant. Currently, the registry contains inventories of more than 400 industrial users of toxic or carcinogenic substances. Updated annually, the data comprise detailed information on 54 target chemicals selected by the department, including the maximum quantities stored and how they are transported. The staff estimates that the development of the computerized registry system cost over $400,000, not counting software development funded by the EPA grant, and annual operating costs.[29]

Community Support

The success of inventory efforts depends on the cooperation of public agencies, such as the fire and police departments, and private groups, such as chemical manufacturers, shippers, and carriers. Advisory committees can be instrumental in obtaining such cooperation. Often appointed by elected officials, such committees are usually multidisciplinary and composed of representatives from first response agencies, local industry, local and interstate carriers, public officials, educators, experts in hazardous materials, and environmentalists.

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[26] Association of Bay Area Governments, San Francisco, CA, *Hazardous Spill Prevention and Response Plan*, 2 vols. (Washington, DC: U.S. Department of Transportation, Research and Special Programs Administration, 1983).

[27] Puget Sound Council of Governments, Seattle, WA, *Central Puget Sound Region Risk Analysis Report: Regional Hazardous Materials Inventory*, interim report (Washington, DC: U.S. Department of Transportation, 1980).

[28] Energy Resources, Inc., *Phase I: Determine the Nature and Scope of Hazardous Materials Transportation in the Massachusetts Region, Volume I* (Cambridge, MA: U.S. Department of Transportation, 1982), pp. 4-36.

[29] Max Eisenberg, Environmental Program, Maryland Department of Health and Mental Hygiene, personal communication, March 1985.

Although private sector support has at times been problematical, in April 1985, CMA announced an industrywide program designed to make chemical industry expertise available to local agencies, including furnishing planning groups with material safety data sheets on commodities manufactured and stored in the community.[30] However, concerns about protecting trade secrets or other information considered to be proprietary (e.g., health or exposure data) have made some manufacturers unwilling to comply with requests for information. In response, many States and municipalities have enacted "right-to-know" laws requiring the release of information on the hazards associated with chemicals produced or used in a given facility. Such laws are useful tools for data-collection activities.

Transportation Studies

In addition to fixed facility inventories, State and local governments have tapped a variety of public and private sources to collect data on truck, rail, air, and water transportation. Small towns and rural counties are particularly interested in transportation data because they see their greatest risk as a hazardous materials accident on an Interstate highway or railroad line passing through their jurisdiction. The type and quantity of hazardous materials carried by each mode and the principal routes used comprise the information most frequently collected for planning, risk analyses, routing decisions, and emergency response preparation. Because the data-gathering problems are different for each mode, highway, rail, air, and water transport are discussed separately.

Truck Studies

State and local data-collection projects reviewed by OTA put the highest priority on information about highway transport of hazardous materials because trucks far outnumber other types of hazardous materials carriers, carry the largest share of the hazardous materials shipments, and are involved in the greatest number of accidents and spills.

Several State databases are currently being developed. New York, for example, is computerizing the data collected by its State Police during their roving truck inspections. Other States with similar information include Virginia,[31] New Mexico,[32] Washington,[33] and Colorado.[34]

State and local planners have devised special means to collect data on highway transport of hazardous materials. The primary methods are questionnaires, visual surveys, and inspections. Several jurisdictions have sent out questionnaires to shippers, carriers, and manufacturers requesting information about hazardous materials shipments and the routes most frequently used.

Analysts in the Puget Sound Region of Washington State, using questionnaire responses, truck route locations, and other information provided by local governmental departments, mapped the routes by which 85 target commodities moved within and through the region. Memphis used a questionnaire to gather data from local shippers and manufacturers,[35] although State Highway Department tax records showed that truckers substantially underreported the flammables category on the questionnaire. In a survey conducted recently of manufacturers and transporters of hazardous materials in the New York City and New Jersey area, only 20 percent of those solicited returned completed questionnaires.[36]

Other jurisdictions have resorted to visual surveys of trucks along major highways. Checkpoints, usually at weigh stations, are set up, and government employees or students count the placarded trucks passing through, recording the commodity class of each shipment. Moreover, several States have conducted surveys of the volume and types of hazardous materials carried by truck. In many cases, the States have had the resources and the authority to combine a visual survey with an inspection and driver interview.

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[30] Chemical Manufacturers Association, press release, Washington, DC, April 1985.

[31] Dennis L. Price, et al., *Multi-Modal Hazardous Materials Transportation in Virginia*, VDOTS/SPO-16 (Richmond, VA: Virginia Department of Transportation Safety, 1981).

[32] James D. Brogan, "Routing Models for the Transportation of Hazardous Materials—State Level Enhancements and Modifications," prepared for presentation at the 64th Annual Meeting of the Transportation Research Board, unpublished typescript, 1985.

[33] National Conference of State Legislatures, *Hazardous Materials Transportation: A Legislator's Guide* (Washington, DC: February 1984).

[34] Ibid.

[35] City of Memphis, Division of Fire Services, *Hazardous Materials Task Force Final Report* (Memphis, TN: 1981), p. 24.

[36] Raymond Scanlon, Port Authority of New York and New Jersey, "A Regional Study on Hazardous Materials Transportation," Howard S. Cullman Fellowship 1982-83 Report, unpublished typescript, p. 15.

A full-scale study was carried out in 1977 to 1978 by the Virginia Department of Transportation Safety as part of a multimodal analysis of hazardous materials transportation. During July and August 1977, all trucks passing 38 survey points on Interstate and primary roads were stopped by State or local police. Shipping papers were inspected, and the drivers were interviewed on the types of materials carried, origin and destination of the trip, and the sequence of routes taken. Officers also checked to see if the placarding was correct and classified the carrier as company-owned, independent, common carrier, or personal vehicle. The study findings provided Virginia officials with a current database on commodity flow and a good measure of the level of compliance with existing Federal and State regulations. The survey found that 13 percent of the trucks carried hazardous materials, of which 76 percent were flammable, combustible, or corrosive liquids. Petroleum products were the most common cargoes. The heaviest hazardous materials traffic was on Interstate highways in and around cities, because urban areas are the principal origins and destinations of petroleum products. The number of placarding violations found by inspectors increased from 34 percent in 1977 to 55 percent in 1978.[37]

Over a 1-year period from October 1981 to September 1982, Washington State surveyed the amount of hazardous materials moving through the State and the type of carrier used. The Washington State methodology was similar to that of the Virginia study. The State Utilities and Transportation Commission set up checkpoints at 11 locations on major highways. All trucks were stopped and checked for 4-hour periods twice a month. The checks included an inspection of shipping papers and an interview with the driver about cargo, quantity carried, origin, destination, and type of carrier. The data were tabulated and sorted using the Automated Hazardous Materials Surveillance Program, a computer program designed for the study that can sort survey data according to date, location, commodity, and truck type and cross-check it with accident and violation data. Researchers found that although independent truckers carry 50 percent of the cargo, they are involved in 75 percent of the accidents.[38]

In 1982 and 1983, the South Dakota Department of Public Safety surveyed drivers and inspected approximately 340,000 trucks at highway checkpoints. Fewer than 1 percent of the trucks carried hazardous materials. The most common hazardous materials cargos were flammable liquids, explosives, corrosives, and flammable gases. The survey found that 55 percent of the hazardous materials shipped was intrastate, primarily flammable liquids and gases. Most intrastate shipments were local deliveries of 25 miles or less, usually originating in one of the larger cities. Although most deliveries were local, carriers indicated that their trucks spent as much as 40 percent of their time on Interstate highways.[39]

OTA research indicates that even when a comprehensive State transportation data-collection effort has been undertaken, cities within the State are often unaware of the resource and consequently do not make use of it.

Rail Studies

Data collection on bulk rail shipments of hazardous materials is extremely important to rail distribution centers such as Memphis and Indianapolis, where data are needed for emergency planning and response purposes. Information on commodities transported, measured by rail carloads, is generally available on request from the major railroads. Information indicating the location of hazardous materials cars in the train and instructions on emergency response procedures are available on the train as well as through railroad offices. However, the availability and detail of the data depend on the extent to which the line is computerized. AAR has compiled a list of the 138 chemicals most frequently carried by the railroads. It has developed detailed fact sheets for these commodities that are incorporated into computerized train information and waybills.[40]

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[37] Price, et al., op. cit., p. XIII.

[38] U.S. Department of Transportation, Materials Transportation Bureau, *SHMED Program Workshop Proceedings, Salt Lake City, Utah, 1983* (Washington, DC: 1983), p. 206.

[39] Ibid., p. 186.

[40] Patrick J. Student (ed.), *Emergency Handling of Hazardous Materials in Surface Transportation* (Washington, DC: Bureau of Explosives, Association of American Railroads, 1981).

Most State and local governments do not collect rail data, although Oregon requests some data from the railroads annually on shipments within its boundaries. Two States with strong rail divisions, New York and New Jersey, do have databases, but these are derived from ICC data. In a few instances, localized data have been collected; the State of Washington[41] and Indianapolis, Indiana,[42] are examples.

Massachusetts, as part of a 1981 planning project, inventoried all the major rail lines in the State and obtained information on the types and quantities—in carloads—of hazardous materials shipped by three of the four largest railroads. Furthermore, Virginia, as part of its multimodal study, collected data from the 10 railroads serving the State. The railroads provided waybill samples for subsections of each line. With this information, analysts estimated the number of cars per day carrying hazardous materials, the tons of hazardous materials carried per day, and the number of trains containing hazardous materials cars. Corrosives accounted for almost half the volume of hazardous materials transported by rail, followed by flammable liquids, and nonflammable compressed gas. The heaviest rail flow of hazardous cargo was in and around cities, a reflection of the demand for petroleum products in urban areas.[43] Finally, the State of Oregon requires annual summaries by milepost segment of all rail shipments of Class A explosives and poisons. These data are used for emergency response planning.

Air Transportation Studies

The transportation of hazardous materials by air is controlled by the FAA's Civil Security Division. Since hazardous shipments account for less than 3 percent of total hazardous materials tonnage moved nationally and since shipments, though numerous, are generally small, State and local governments have not been particularly concerned about air transport. Only Virginia has collected any primary data,[44] consisting of information on hazardous materials passing through many of its major airports. However, FAA conducted surveys of the types and quantities of hazardous materials shipments at the New Orleans, Memphis, and Boston airports, and provided local planners with the data. Data on shipment characteristics for air freight carriers can be obtained to augment FAA data. Local planners do not have access to information on hazardous materials carried by military aircraft.

Water Transportation Studies

Ports play an important role in hazardous materials commerce. For example, 4.5 million tons of hazardous materials pass through the Port of Seattle each year—about 27 percent of the total cargo handled. Over half of the Nation's chemicals move through the Port of Houston annually. State and local planners rely on data from the Army Corps of Engineers as their primary data source. The Corps provided Massachusetts researchers with the annual tonnage by commodity group for 1978 for both Boston Harbor and the nearby New Bedford Harbor. However, the data classification system used by the Corps does not always identify specific commodities—for example, the "Basic Chemicals" category contains some nonhazardous materials. This leads to overestimates of the actual amounts of hazardous materials, but none of the States or cities contacted by OTA found this a sufficient reason to conduct an additional study. Two port cities, Seattle and Boston, supplemented the Corps' data with information on tonnage of commodities available from local regulatory agencies and the U.S. Coast Guard.

Shipments of Radioactive Materials and Wastes

In 1973 to 1975 and 1977 to 1981, two series of studies involving a number of States were conducted jointly by NRC and DOT for the purpose of collecting information on the transportation of low-level radioactive materials. Data were gathered on low-level radioactive waste sites; shipments by highway, air, and water; and the history of accidents and incidents. Findings were used to determine gaps in Federal regulatory programs and in Federal and State enforcement efforts.[45]

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[41] National Conference of State Legislatures, *Hazardous Materials Transportation: A Legislator's Guide*, op. cit.

[42] City of Indianapolis, *Demonstration Project To Develop a Hazardous Materials Accident Prevention and Emergency Response Program: Final Reports, Phases I-IV* (Washington, DC: U.S. Department of Transportation, Research and Special Programs Administration, 1983).

[43] Price, et al., op. cit., pp. 113-115.

[44] Ibid.

[45] Stephen N. Salomon, *State Surveillance of Radioactive Materials Transportation*, NUREG-1015 (Washington, DC: U.S. Nuclear Regulatory Commission, Office of State Programs, 1984), p. 5.

Data on movement for high-level radioactive materials and wastes, including spent fuel, are treated differently from other hazardous materials data—both legally and institutionally. DOT has primary responsibility for monitoring low-level radioactive materials and wastes, while DOT and NRC share regulatory and enforcement authority for high-level radioactive materials and wastes. NRC requires licensees to provide advance notice for certain nuclear shipments; to provide physical protection of special nuclear materials including spent nuclear fuel to prevent theft, diversion, or sabotage; and to notify NRC regional offices of impending special shipments of nuclear materials. A study conducted by the Battelle Memorial Institute for DOT analyzed States' use of the information on transport shipments of spent nuclear fuel through their jurisdictions. Of the States surveyed, 14 out of 15 maintain a file of notifications. Five States pass the information on to other State agencies; two make subsequent notifications to other divisions of the same agencies; and six subsequently notify officials at both the State and local levels. Two States make no further notification for security reasons. The primary benefit of notification identified by almost all States surveyed was that awareness of impending shipments allowed them to take precautions and alert emergency response agencies.[46]

Registration Notification Requirements as Tools for Data Gathering

OTA examined registration and notification requirements as potential data resources for hazardous materials planning. The most basic information needed is the identities and locations of suppliers, manufacturers, and carriers of hazardous materials. A governmental entity may acquire this information by requiring such firms to register. Although it has the authority to do so, RSPA does not have a registration program and thus has no complete record of the firms it regulates or their locations. Because RSPA cannot provide this basic information, some State and local governments have imposed their own registration requirements. Pennsylvania, California, and Denver, for example, require registration. However, the purpose of the Denver registration program, enacted in 1985, is not primarily to gather information, but rather to fund enforcement activities.[47]

State and local governments typically give two reasons for enacting notification requirements: to provide data for planning (including better routing and safety regulations), and to improve emergency response. The Battelle study, cited above, identified 136 State and local notification laws pertaining to hazardous materials transportation. Over two-thirds of the jurisdictions identified information needs for planning as an important reason for their laws, citing the need to know about the types and quantities of materials shipped through their jurisdictions, trip scheduling, and routes frequently used. Many also indicated they require advance notification to alert response teams when a potentially hazardous shipment is due.

The study concluded that most of these regulations produce little usable data either because they apply to a very narrow range of materials or because they are not enforced. For further discussion of registration and notification issues, see chapter 4.

Hazard and Risk Assessments

Federal Risk Assessment.—During the last decade, the Federal Government has sponsored a number of efforts to formulate risk assessment models and apply them to hazardous materials transportation safety. The Coast Guard, for example, used models originally developed for emergency response purposes as the basis for its Population Vulnerability Model, which calculates the travel and chemical reactions of marine cargo spills over time, and estimates their effects on the surrounding population and property.[48] Sandia Laboratories quantified the severities of hazardous materials transportation accidents in the air, truck, and rail modes.[49] Battelle Pacific Northwest Laboratory used Sandia's results to develop a general risk assessment methodology, which was first applied to truck shipments of radioactive materials,[50] and later extended to other modes of transportation and to other hazardous materials transportation by truck and rail in the Central Puget Sound Region.[51]

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[46] Battelle Memorial Research Laboratories, Battelle Human Affairs Research Center, *Assessment of State and Local Notification Requirements for Transportation of Radioactive and Other Hazardous Materials* (Seattle, WA: Jan. 11, 1985), pp. 88-112.

[47] Cathy Reynolds, Denver City Council, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Transportation of Hazardous Materials Advisory Panel," unpublished typescript, June 27, 1985, p. 230.

[48] National Materials Advisory Board, *The Application of Quantitative Risk Assessment Techniques in the U.S. Coast Guard Regulatory Process*, NMAB-402 (Washington, DC: National Academy Press, 1982).

[49] R.K. Clarke, et al., *Severities of Transportation Accidents*, SLA-74-0001 (Albuquerque, NM: Sandia National Laboratories, 1976).

DOT has sponsored several risk assessments concerning the rerouting of hazardous materials. For example, a computer-based network model of the U.S. rail system was used to study the effects on risk levels of a policy to reroute railroad shipments of hazardous materials to avoid populated areas.[52] The model was also used in conjunction with a study of catastrophic derailment risks.[53] Risk-based criteria have been developed to enable State and local authorities to designate routes for truck shipments of hazardous materials. DOT has also sponsored the development of risk assessment worksheets and guidelines for large and small community routing and emergency planning.[54]

State and Local Hazard and Risk Assessment.—Public concerns about the risks of hazardous materials transportation are likely to persist and intensify, accentuating the need for risk or hazard assessment at the regional level. This generally consists of two stages: 1) the development of an inventory of hazardous materials activity and exposure in the region, and 2) the estimation and evaluation of risks based on that information. OTA finds that the first stage can be performed very well at the State and local level. In fact, the data-collection process can be beneficial in itself, because of the contacts and communication it fosters. It is the process of evaluating the risks and making decisions based on them that has been the source of difficulty, especially in the cities where disputes over routing decisions have reached the courts. The worksheet approaches developed under DOT sponsorship for highway routing[55] and community planning[56] are helpful, but insufficient, because they reduce the results to a single number known as "expected risk." A risk profile showing frequency in comparison to consequence is more helpful than a single number, which provides no insight into whether the concern is about frequent spills that may be of low consequence (gasoline, for example) or infrequent spills of a more dangerous substance like chlorine, and does not usually indicate the uncertainty of the risk estimate.

The importance of making regionally acceptable risk-based decisions suggests that DOT could provide State and local governments with better tools for risk assessment. The technical complexities of a thorough risk assessment could be handled through an assistance program similar to the one employed by the Urban Mass Transportation Administration for those using the Urban Transportation Planning System (UTPS) computer software as a basis for regional transportation planning.[57] A computer model estimating population at risk along transportation corridors has been developed at Oak Ridge National Laboratory. The model may be revised for microcomputers, and with a good user's manual could be a useful risk assessment tool for State and local governments.[58] In addition, following the UTPS precedent, a program of training courses could be established and a staff organized for system maintenance and assistance to the users. This type of program would provide practical assistance for jurisdictions considering routing alternatives.

OTA reviewed a number of State and local hazard and risk studies, because they are important for contingency planning, for practical decisions about locating response equipment and allocating manpower, and for developing routing plans. This last area, routing, has been the source of a great deal of interjurisdictional conflict; for further discussion, see chapter 4.

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[50] T.I. Sweeney, et al., *An Assessment of the Risk of Transporting Plutonium Oxide and Liquid Plutonium Nitrate by Truck*, Report No. 1846 (Richland, WA: Battelle Pacific Northwest Laboratory, 1975).

[51] W.B. Andrews, *Hazardous Materials Transportation Risks in the Puget Sound Region* (Richland, WA: Battelle Pacific Northwest Laboratory, 1981).

[52] T.S. Glickman, "Rerouting Railroad Shipments of Hazardous Materials To Avoid Populated Areas," *Accident Analysis and Prevention*, vol. 15, No. 5, 1983, pp. 329-335.

[53] T.S. Glickman and D.B. Rosenfield, "Risks of Catastrophic Derailments Involving the Release of Hazardous Materials," *Management Science*, vol. 30, No. 4, 1984, pp. 503-511.

[54] E.J. Barber and L.K. Hildebrand, Peat, Marwick, Mitchell & Co., *Guidelines for Applying Criteria To Designate Routes for Transporting Hazardous Materials*, FHWA-IP-80-20 Implementation Package (Washington, DC: Federal Highway Administration, 1980); and E.R. Russell, et al., *A Community Model for Handling Hazardous Materials Transportation Emergencies* (Washington, DC: U.S. Department of Transportation, Research and Special Programs Administration, 1981).

[55] Barber and Hildebrand, op. cit.

[56] Russell, et al., op. cit.

[57] U.S. Department of Transportation, *User-Oriented Materials for UTPS—An Introduction to Urban Travel Demand Forecasting* (Washington, DC: 1977).

[58] Edward L. Hillsman, Research Staff, Oak Ridge National Laboratory, personal communication by letter, May 15, 1986.

Few jurisdictions have used sophisticated mathematical techniques of risk analysis to estimate the probability of an incident and its severity. Most communities find it adequate to map the areas where the risk of a hazardous materials incident is highest or where there would be the greatest public danger or the most damage. Data for this type of study can be assembled either from a fixed facility inventory or a transportation study. Much useful information is also available from public records routinely kept for other purposes by State and local public works, transportation, environmental, and planning departments. Normally, a hazard assessment requires the following kinds of information:

- transportation network maps and descriptions;
- highways and streets used by hazardous materials carriers;
- tunnels, bridges, and rail crossings;
- railroad yards and truck terminals;
- highway, rail, air, and water accident data;
- locations of past hazardous materials incidents and materials involved;
- concentrations of hazardous materials manufacturing or storage sites;
- areas of high population density and environmental sensitivity;
- location of schools, hospitals, and other especially vulnerable sites; and
- water supply and sewer facilities.

A risk assessment could also include special analyses of the types and quantities of hazardous materials transported through the community and the location of emergency response teams and equipment.

Conclusions

OTA finds that Federal data-collection activities provide modal transportation data of varying completeness. OTA experience in analyzing many Federal databases for this report establishes that data integration is not a technical problem; with careful analysis, comparative data on commodity flow can be developed. However, the quality of the data is not outstanding, and the data are incomplete in numerous areas, particularly for truck and air transport. These shortcomings mean that current policy decisions must be based on inadequate information, a separate concern that warrants further study.[59] OTA concludes that if RSPA were to conduct analyses of existing data similar to that undertaken for this study, it would benefit by having aggregate commodity flow information to use as a denominator in analyzing its spill and accident records. Such data might not completely satisfy State or local needs for information about shipments, but they can show State-to-State and regional transportation patterns.

Furthermore, OTA concludes that State and local data collection has enormous value in and of itself. The information gathered is only part of that value; the communication, cooperation, and coordination between the public and private sectors that are an inevitable result of the effort are extremely important. Community right-to-know laws are useful tools for State and local governments in obtaining data, and national right-to-know legislation would bolster implementation of such laws, where industry resistance remains.

Some city officials and planning personnel have continued to express a need for a national commodity flow data resource. An annual printed summary provided by DOT is most frequently mentioned, and OTA concludes that annual DOT summaries of shipments would provide useful national, regional, and State flow pattern information. Although some desire for real-time notification of especially high-hazard shipments has been voiced, emergency response officials consulted by OTA generally prefer to do local inventories and transportation surveys and to prepare their personnel for any eventuality. They point out that detailed real-time information would be overwhelming to track and useless for planning and preparedness.[60] As one fire chief said: "What am I supposed to do? Follow the truck around waiting for an accident to happen?"[61]

However, some local officials who want real-time tracking of hazardous materials, have called for DOT to develop a publicly accessible database to provide information on shipments.[62] Such real-time data are probably the only way to keep current on shipments if that is the goal, since many hazardous materials orders are for truck delivery within 36 hours or less. Other shipments are seasonal, related to agricultural or manufacturing cycles. Finally, customers may suddenly change supply sources for economic reasons, rendering periodic data collection instantly obsolete. The technological groundwork for a real-time system to track hazardous waste shipments, which represent less than 1 percent of hazardous materials shipments, has been developed by a private firm, although the system has not been tested in operation.

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[59] Martin Crutsinger, "U.S. Statistical Problems Seen," *Washington Post*, Mar. 18, 1986, p. E1.

[60] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, op. cit., ch 4.

[61] Thomas Hawkins, Jr., Chief, Arlington County Fire Department, Arlington, VA, personal communication, January 1986.

However, even if the technical difficulties for implementing such a system for all hazardous materials could be resolved, the cost has been estimated to be more than $100 million.[63] OTA finds that while development of a real-time database limited to tracking only certain highly hazardous shipments is technically feasible, its utility for emergency response is questionable. **Furthermore, development of online telephone access to real-time information on all hazardous materials shipments is not feasible, nor would it be cost-effective.**

If Congress chooses to provide support for data gathering, several options are available. DOT could be required to exercise its authority under 49 U.S.C., Section 1805(b) and develop a registration program for hazardous materials shippers, transporters, and container manufacturers. **OTA finds that a registration program would provide DOT with essential information about the community it regulates and with some commodity shipment information that could be made available to State and local jurisdictions.** DOT could make use of the information for setting priorities for rulemaking, research, and for enforcement actions. A modest registration fee could be imposed to cover costs of administering the program.

In addition, Congress could require DOT to integrate, analyze, and report annually on trends from relevant Federal databases kept by the modal administrations and the Bureau of the Census. For this effort to be effective:

- The collection of data on truck movements must be improved.
- Conversion or bridge tables for the commodity codes used by different agencies and in 49 CFR, Section 172, must be created. Alternatively, each agency might be required to use a common code for commodities.
- Sufficient funds must be allocated to support the effort. OTA estimates that the equivalent of one man-year of effort, between $45,000 and $75,000, would provide a modest start.

Finally OTA finds that a summary of commodity flow data in comparison with DOT accident data in the required annual report to Congress would be useful.

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[62] The National League of Cities (NLC) has retained in its transportation position paper a request for a U.S. Department of Transportation report on commodity flow. Barbara Harsha, NLC transportation staff, personal communication, January 1986.

[63] John Mulholland, Source Data Network, personal communication, November 1985.

PART II: ACCIDENT AND SPILL INFORMATION SYSTEMS

Statistics generated by hazardous materials accident and spill databases can be used within agencies and departments to measure program effectiveness, to improve accident and spill prevention by identifying and analyzing causes and events, and for regulatory and enforcement analysis. A reliable incident/accident database can also be used to improve emergency response and disaster preparedness by identifying trouble spots. Knowledge of high accident frequency locations and the flow of hazardous materials provides communities with an understanding of the probability of an accident or spill and the materials likely to be involved, tools for risk assessment.

Spill Report Systems

Each of the DOT modal administrations keeps separate modal accident data, and several agencies keep data specifically on releases of hazardous materials. However, RSPA is the official DOT repository of hazardous materials release information. A transportation-related incident or release is defined in DOT regulations as any unintentional release of a hazardous material during transportation, or during loading/unloading or temporary storage related to transportation. Every release, except for those from bulk water transporters and those motor carrier firms doing solely intrastate business, must be reported to RSPA in writing as prescribed in 49 CFR, Parts 171, 174.45 (rail), 175.45 (air), and 176.48 (marine vessels). The only other exceptions are consumer commodities that present a limited hazard during transportation, such as electric storage batteries and certain paints and materials. These exceptions do not apply to hazardous waste releases or those involving aircraft. A written response must be prepared by the carrier on a prescribed form, F5800.1 (see figure 2-2), and submitted to RSPA within 15 days of discovery of the release. While carriers are required to report, any interested party may report. A RSPA contractor logs the written report information into a computerized database.

This database, called HMIS, became the central system for spill data in 1971. Prior to that time, hazardous materials regulatory authority had been divided among DOT modal administrations, and a wide range of hazardous materials reporting systems had evolved. Since collecting and maintaining this data became a RSPA responsibility, the only major change in the incident reporting requirements occurred in 1981, when battery spills and spills of less than 5 gallons of paint were eliminated from required reporting, reducing the number of reports processed by RSPA considerably. The HMIS database is the only one devoted exclusively to hazardous materials transportation spills, and consequently is the one most useful for examining packaging, labeling, accident cause, and safety issues.

Carriers are also required to make an immediate telephone report to the National Response Center (NRC) when a spill has resulted in one or more of the following consequences as a direct result of the hazardous material:

- a fatality;
- a serious injury requiring hospitalization;
- estimated carrier or other property damage exceeding $50,000;
- fire, breakage, or suspected contamination involving the shipment of radioactive materials or etiologic agents; and
- a situation of such a nature that the carrier judges should be reported.[64]

NRC is staffed 24 hours a day by the Coast Guard and handles the reporting of all significant hazardous materials spills under agreements with DOT and EPA. Established in 1974, NRC has two 24-hour toll-free telephone lines to receive notifications and several other lines to relay calls to emergency response agencies that may need to know of the release. **However, the NRC telephone number does not appear in DOT's *Emergency Response Guidebook*.***

Telephone reports received by NRC are logged every evening into a computer operated at the DOT Transportation Systems Center where the information is retained and managed by RSPA. RSPA uses the NRC telephone reports occasionally, for serious releases, but relies primarily on the written reports that it receives directly as the basis for its database on incidents, casualties, associated damages, and a multitude of descriptors related to the material, container, cause, and location of the release.

In many cases, carriers involved in a release have telephoned CHEMTREC, a chemical transportation emergency center established in 1971 by CMA. Since 1980, CHEMTREC has been required to notify NRC of significant hazardous materials transportation releases—those which have or might cause considerable harm to the public or the environment. A call to CHEMTREC fulfills only the NRC telephone reporting requirements; it does not fulfill the Federal written reporting requirements. The CHEMTREC toll-free telephone number is given in DOT's *Emergency Response Guidebook*.

Although reporting releases is a regulatory requirement, OTA found evidence that the compliance rate is low. One State official has estimated that 30 to 40 percent of reportable hazardous materials incidents are never reported.[65] EPA Region VII officials have independently estimated that only about 10 percent of all reportable releases under 100 gal-

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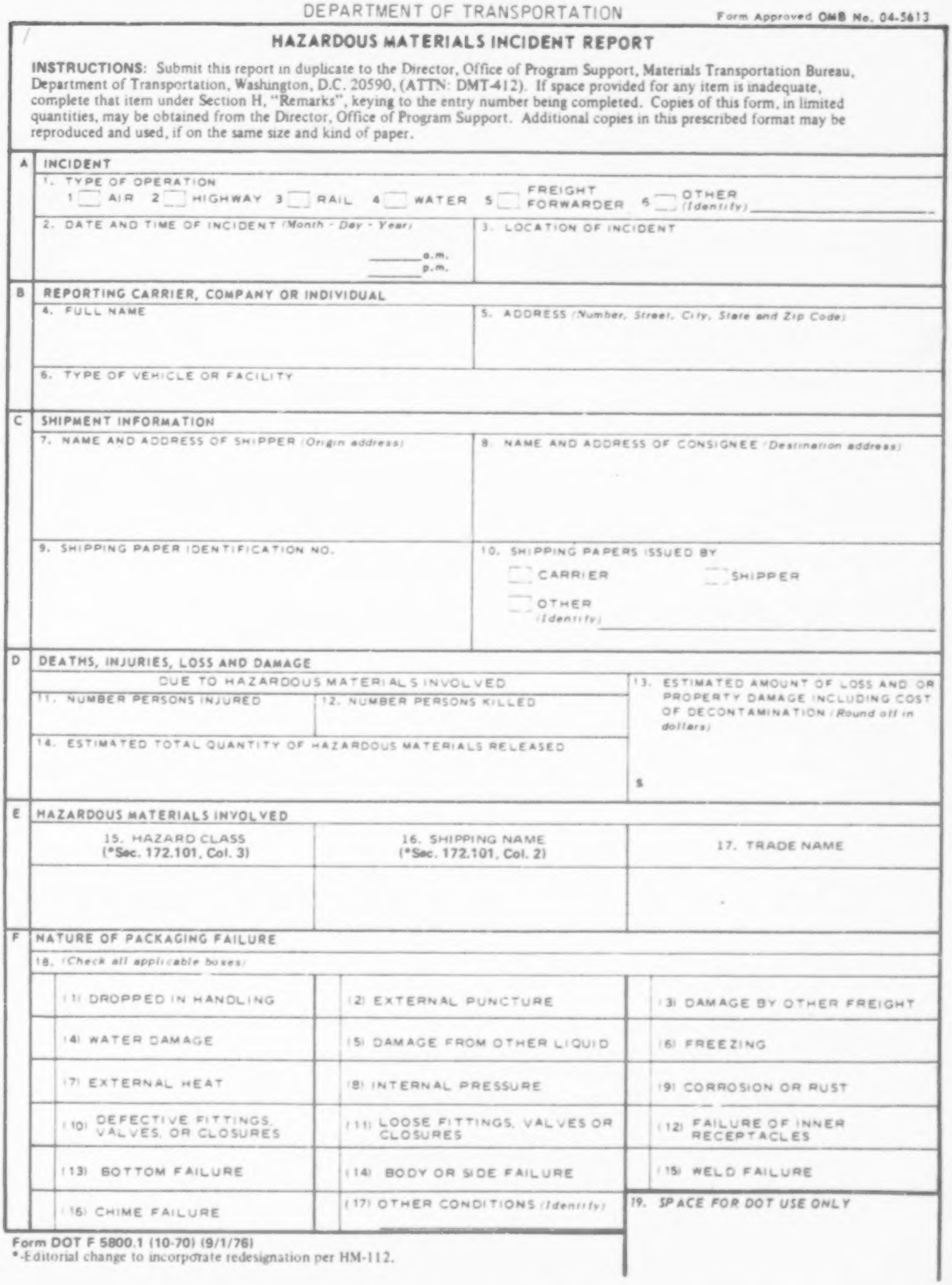
[64] 49 CFR 171.15.

*U.S. Department of Transportation publishes and distributes the *Emergency Response Guidebook* free of charge on request. It contains examples of hazardous materials marking and shipping information and basic guidance on appropriate first response actions.

[65] Stephen W. Ballou, "Memo From Iowa Department of Water, Air and Waste Management," unpublished typescript, May 6, 1985.

Figure 2-2.—DOT Incident Report Form F5800.1



DEPARTMENT OF TRANSPORTATION

Form Approved **OMB No. 04-5613**

HAZARDOUS MATERIALS INCIDENT REPORT

INSTRUCTIONS: Submit this report in duplicate to the Director, Office of Program Support, Materials Transportation Bureau, Department of Transportation, Washington, D.C. 20590, (ATTN: DMT-412). If space provided for any item is inadequate, complete that item under Section H, "Remarks", keying to the entry number being completed. Copies of this form, in limited quantities, may be obtained from the Director, Office of Program Support. Additional copies in this prescribed format may be reproduced and used, if on the same size and kind of paper.

A INCIDENT

1. TYPE OF OPERATION
1 ☐ AIR 2 ☐ HIGHWAY 3 ☐ RAIL 4 ☐ WATER 5 ☐ FREIGHT FORWARDER 6 ☐ OTHER *(Identify)* ____________________

2. DATE AND TIME OF INCIDENT *(Month - Day - Year)*
________ a.m.
________ p.m.

3. LOCATION OF INCIDENT

B REPORTING CARRIER, COMPANY OR INDIVIDUAL

4. FULL NAME

5. ADDRESS *(Number, Street, City, State and Zip Code)*

6. TYPE OF VEHICLE OR FACILITY

C SHIPMENT INFORMATION

7. NAME AND ADDRESS OF SHIPPER *(Origin address)*

8. NAME AND ADDRESS OF CONSIGNEE *(Destination address)*

9. SHIPPING PAPER IDENTIFICATION NO.

10. SHIPPING PAPERS ISSUED BY
☐ CARRIER ☐ SHIPPER
☐ OTHER *(Identify)* ____________________

D DEATHS, INJURIES, LOSS AND DAMAGE

DUE TO HAZARDOUS MATERIALS INVOLVED

11. NUMBER PERSONS INJURED

12. NUMBER PERSONS KILLED

13. ESTIMATED AMOUNT OF LOSS AND OR PROPERTY DAMAGE INCLUDING COST OF DECONTAMINATION *(Round off in dollars)*
$

14. ESTIMATED TOTAL QUANTITY OF HAZARDOUS MATERIALS RELEASED

E HAZARDOUS MATERIALS INVOLVED

15. HAZARD CLASS (*Sec. 172.101, Col. 3)	16. SHIPPING NAME (*Sec. 172.101, Col. 2)	17. TRADE NAME

F NATURE OF PACKAGING FAILURE

18. *(Check all applicable boxes)*

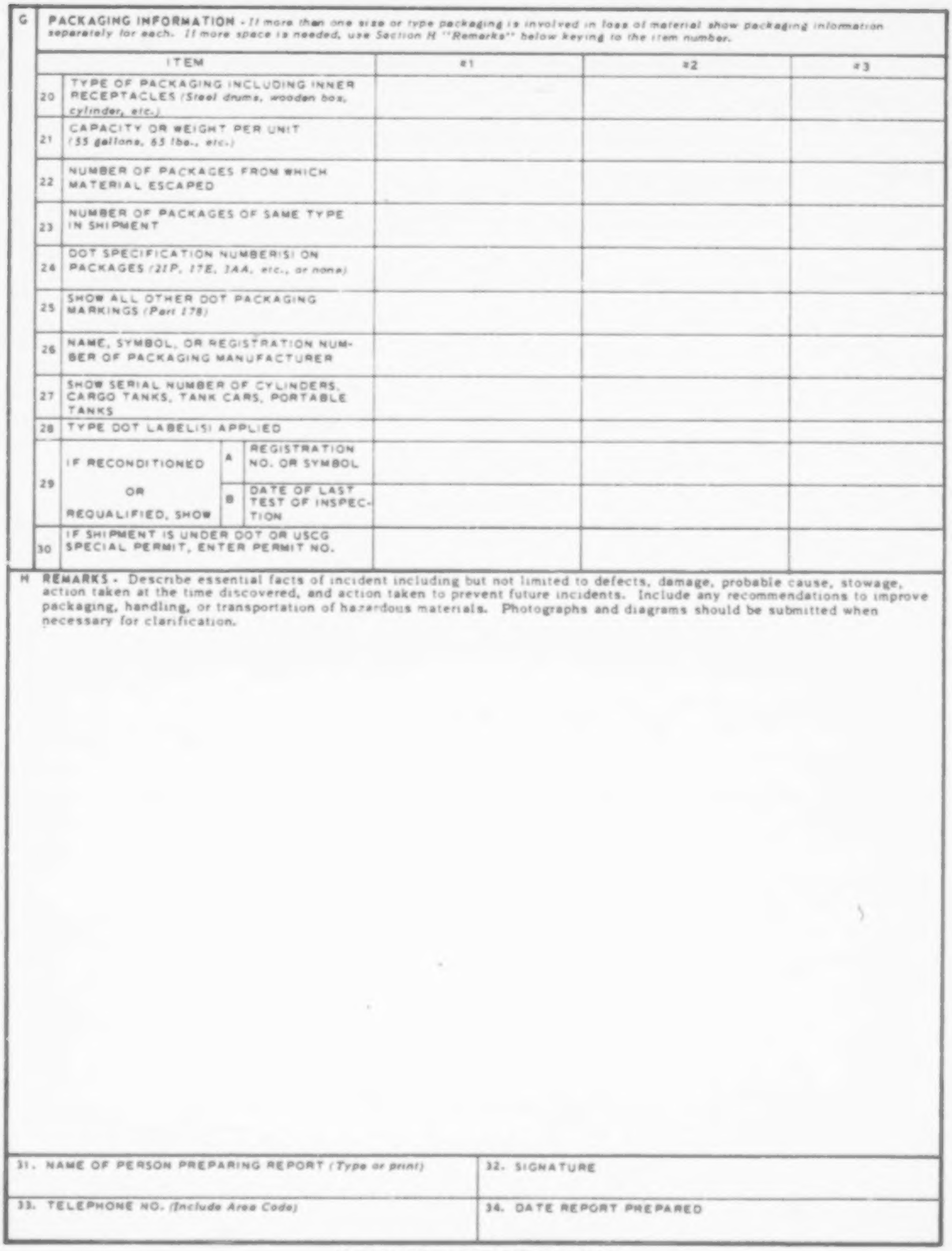
☐	(1) DROPPED IN HANDLING	☐	(2) EXTERNAL PUNCTURE	☐	(3) DAMAGE BY OTHER FREIGHT
☐	(4) WATER DAMAGE	☐	(5) DAMAGE FROM OTHER LIQUID	☐	(6) FREEZING
☐	(7) EXTERNAL HEAT	☐	(8) INTERNAL PRESSURE	☐	(9) CORROSION OR RUST
☐	(10) DEFECTIVE FITTINGS, VALVES, OR CLOSURES	☐	(11) LOOSE FITTINGS, VALVES OR CLOSURES	☐	(12) FAILURE OF INNER RECEPTACLES
☐	(13) BOTTOM FAILURE	☐	(14) BODY OR SIDE FAILURE	☐	(15) WELD FAILURE
☐	(16) CHIME FAILURE	☐	(17) OTHER CONDITIONS *(Identify)* ____________		

19. *SPACE FOR DOT USE ONLY*

Form DOT F 5800.1 (10-70) (9/1/76)

*-Editorial change to incorporate redesignation per HM-112.

Figure 2-2.—DOT Incident Report Form F5800.1—Continued



G **PACKAGING INFORMATION** - *If more than one size or type packaging is involved in loss of material show packaging information seperately for each. If more space is needed, use Section H "Remarks" below keying to the item number.*

	ITEM			#1	#2	#3
20	TYPE OF PACKAGING INCLUDING INNER RECEPTACLES *(Steel drums, wooden box, cylinder, etc.)*					
21	CAPACITY OR WEIGHT PER UNIT *(55 gallons, 65 lbs., etc.)*					
22	NUMBER OF PACKAGES FROM WHICH MATERIAL ESCAPED					
23	NUMBER OF PACKAGES OF SAME TYPE IN SHIPMENT					
24	DOT SPECIFICATION NUMBER(S) ON PACKAGES *(21P, 17E, 3AA, etc., or none)*					
25	SHOW ALL OTHER DOT PACKAGING MARKINGS *(Part 178)*					
26	NAME, SYMBOL, OR REGISTRATION NUMBER OF PACKAGING MANUFACTURER					
27	SHOW SERIAL NUMBER OF CYLINDERS, CARGO TANKS, TANK CARS, PORTABLE TANKS					
28	TYPE DOT LABEL(S) APPLIED					
29	IF RECONDITIONED OR REQUALIFIED, SHOW	A	REGISTRATION NO. OR SYMBOL			
		B	DATE OF LAST TEST OF INSPECTION			
30	IF SHIPMENT IS UNDER DOT OR USCG SPECIAL PERMIT, ENTER PERMIT NO.					

H **REMARKS** - Describe essential facts of incident including but not limited to defects, damage, probable cause, stowage, action taken at the time discovered, and action taken to prevent future incidents. Include any recommendations to improve packaging, handling, or transportation of hazardous materials. Photographs and diagrams should be submitted when necessary for clarification.

31. NAME OF PERSON PREPARING REPORT *(Type or print)*	32. SIGNATURE
33. TELEPHONE NO. *(Include Area Code)*	34. DATE REPORT PREPARED

Reverse of Form DOT F 5800.1 (10-70)

lons are reported to EPA, the States, or NRC, although 90 percent of releases over 100 gallons are reported; and 20 percent of all polychlorinated biphenyl releases are reported.[66] Transportation spills constitute 26 percent of the total number of incident reports compiled by this EPA region.[67]

The hazardous materials regulated community is so large that inspection of every facility, manufacturer, shipper, and carrier is not feasible. Enforcement agencies use a variety of criteria to determine how best to deploy their inspection resources, and violation and release records are frequently used to identify areas on which to concentrate inspection efforts. The Coast Guard, for example, has redirected its inspection efforts to "high-priority" vessels, the definition of which includes a vessel with a reported previous hazardous materials incident. BMCS and the Federal Railroad Administration also use selection criteria to determine inspection priorities, based in part on release experience.[68] However, since compliance with the release reporting requirement is low, many firms go for years without seeing an inspector, and problems remain uncorrected.

The incentive for reporting, as required by the Federal enforcement program, is to avoid the possibility of a civil or criminal penalty that can be imposed if a person knowingly violates a Hazardous Materials Transportation Act regulation. Civil penalties, more common than criminal penalties, can include a liability of up to $10,000 per violation or 1 year imprisonment, or both. Criminal penalties are subject to a fine of up to $25,000 or 5 years imprisonment, or both. However, even when violators are penalized, the level of the penalty is often insufficient to deter future violations, because the costs of compliance are greater than those of potential penalties. Thus, some operators consider penalties to be an occasional cost of doing business.[69] For further discussion of penalty levels, see chapter 4.

Despite widespread mistrust in the reliability of the HMIS, its information is acknowledged to be the best available, and frequent requests for Federal accident and spill data come from the private sector, including legal professionals, industry analysts, private citizens, consultants, and university researchers. In most cases, DOT handles these through distribution of a hard copy of the requested material, although a few databases are also accessible through online queries via telephone access.

Modal Accident Data Systems

Independent of the RSPA release reporting system are several accident reporting systems maintained by various modal administrations.* These systems were designed to cover all transportation accidents under the jurisdiction of the particular administration, not just those involving hazardous materials. In many cases, however, special identifiers have been placed in the reporting format that permit the designation of an accident involving hazardous cargo. These databases are useful secondary data, as the accident reports are usually based on reporting procedures independent of RSPA procedures, and thus are not subject to the same deficiencies. However, the different agencies use different location codes for accidents, ranging from point codes to relative location from a nearby town, making it difficult to identify routes where route characteristics may contribute. In addition, other sources of information exist that are useful for understanding releases and accidents related to the transportation of hazardous materials.

The **Coast Guard** maintains two databases that include recognition of accidents and spills involving hazardous materials: 1) the Commercial Vessel Casualty File (CVCF), and 2) the Pollution Incident Reporting System (PIRS). These databases could be used to fill a gap in the HMIS, which is particularly weak in the marine mode.

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[66] ICF, Inc., "Economic Analysis of Reportable Quantity Adjustments Under Sections 102 and 103 of the Comprehensive Environmental Response, Compensation, and Liability Act," unpublished typescript, March 1985.

[67] William J. Keffer, "Incident Activity Report," periods covering June-August 1985, memo to distribution, U.S. Environmental Protection Agency Region VII.

[68] U.S. Department of Transportation, Research and Special Programs Administration, *A Guide to the Federal Hazardous Materials Transportation Regulatory Program* (Washington, DC: January 1983).

[69] National Conference of State Legislatures, *Hazardous Materials Incident Reports* (Washington, DC: U.S. Department of Transportation, Research and Special Programs Administration, February 1984).

*The term "accident" refers to a vehicular accident. Most hazardous materials transport releases are not caused by vehicular accidents themselves, but by other causes such as faulty valves or closures. Conversely, most vehicular accidents do not involve vehicles that are transporting hazardous materials.

CVCF includes all vessel accidents, both domestic and foreign, occurring since 1963 in U.S. waters, subject to the following criteria:

- actual physical damage to property in excess of $25,000;
- material damage affecting the seaworthiness, maneuverability, or efficiency of a vessel;
- stranding or grounding (with or without damage);
- loss of life; and/or
- injury causing any person to remain incapacitated for a period in excess of 72 hours, except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty.

The records include vessel characteristics, event, cause, fatalities/injuries, and monetary damage; specific vessel codes indicate whether the vessel was carrying hazardous cargo.[70]

The PIRS database consists of reports generated in response to requirements of the Federal Water Pollution Control Act and the Comprehensive Environmental Response, Compensation, and Liability Act. It includes all polluting releases into U.S. waters and identifies transport-related releases by hazardous substance name. The database also includes the quantity released, cause of the incident, and the date and location.[71] According to Coast Guard officials, the PIRS database has unedited files where major errors often appear, and only closed cases are available for analysis from the database.

The **Bureau of Motor Carrier Safety** has maintained a database on accidents since 1973. It includes any motor carrier accident in which a fatality or injury occurred or for which at least $2,000 in property damage was incurred. Reports are filed on Form 50-T, which requests carrier identification and address, location of the incident, characteristics of the event, cause, information on the cargo, and consequences of the accident. The carrier identification, cargo description, and certain accident characteristics are recorded, so that congruence between the HMIS database and BMCS database may be achievable for releases caused by vehicular accidents.

The Federal Railroad Administration maintains its own accident/incident database from information generated by railroads, inspectors, and RSPA. The database includes information similar to the accident characteristics described in the Coast Guard and BMCS databases, although FRA has its own definition of incidents and accidents. FRA performs a number of internal consistency checks to strengthen the validity of the database. These include the elimination of double-counting of events when more than one railroad files a report, spot checks of suspicious events, and occasional audits of railroad internal records. Over the past 10 years, over 80,000 records have been included in the FRA file. Approximately 1,000 of these have involved releases of hazardous materials. FRA also maintains an RSPA-enhanced database on hazardous materials spills, which includes accident location information, railroad code, and STCC.

The Federal Aviation Administration maintains a computerized accident/incident database at its National Field Office in Oklahoma City. This database consists of air accidents officially reported to the National Transportation Safety Board (NTSB) and reports filed by FAA field inspectors. FAA makes a distinction between an accident and an incident based on the dollar damage incurred in the reported event. The FAA database includes the pilot involved, the carrier, time-of-day, and other descriptors such as contributing circumstances and accident (incident) severity. It is apparently possible to identify hazardous materials accidents/incidents in this database; according to FAA officials, 11 accidents/incidents involving hazardous materials have been reported in the past 5 years. Although OTA made several requests for additional information, FAA did not respond.

The National Highway Traffic Safety Administration's (NHTSA) National Center for Statistics and Analysis maintains accident data on police-reported accidents, including those resulting in nonfatal injury and/or property damage. The file, the National Accident Sampling System (NASS), was developed to provide an automated, comprehensive national traffic accident database. The accidents investigated in NASS are a probability sample of all police-reported accidents in the United States. The data for a NASS-selected accident is collected by each State under contractual agreement with NHTSA and includes characteristics of the accident, driver, occupants, and vehicle. Data relevant to this study include the vehicle number, type of carrier, and whether BMCS regulated; characteristics of the roadway where the accident occurred, vehicle body type, body/trailer configuration, vehicle curb and cargo weight; and impact of the accident. Although the specific commodity being carried is not described, sufficient information exists to track accidents likely to involve hazardous materials, and recently a hazardous materials "flag" was added to the record description. Outside of the date and location of the accident, there is little congruence with the data collected by RSPA; however, the characteristics of the driver, road, and traffic may be important determinants of hazardous materials accidents.[72]

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[70] U.S. Coast Guard, *Coding Instructions for the Automated File of Commercial Vessel Casualties* (Washington, DC: February 1984).

[71] U.S. Coast Guard, *Polluting Incidents In and Around U.S. Waters, Calendar Year 1981 and 1982* (Washington, DC: December 1983).

Those accidents resulting in loss of human life are also classified separately in NHTSA's Fatal Accident Reporting System (FARS). The FARS file contains data on vehicles and persons involved in fatal accidents, defined as an accident in which an accident-related death occurred within 30 days of the accident. FARS includes all fatal accidents that occur in the United States. Other than this distinction, however, the information collected parallels the NASS data structure.[73] Table 2-10 shows the incident/accident databases.

Other Relevant Databases

Environmental Protection Agency.—EPA regional offices receive notifications from many sources of releases of hazardous substances; the reports are integrated into a regional release reporting system. Data recorded include the release date, company involved, spill location, nature of the emergency, material spilled and volume, source of the spill, responding agency, nature of the response, and resolution. Several EPA regions maintain this information in computerized files. EPA uses National Response Center reports in addition to spills reported to EPA regional offices, States, and local governments to formulate regulatory policy.

National Response Center.—Although telephone reports to NRC are primarily to stimulate a response action, the information provided can be used for policy analysis. Data items include the location of the incident, mode of transportation involved, material involved, and quantity released. The material definitions are coded differently from those in HMIS, and causal factors are not considered in any fashion. However, the NRC database provides a more balanced picture of releases by different modes, particularly marine transport.

National Transportation Safety Board.—NTSB investigates transportation accidents in any mode, based on the definition in 49 CFR of a major vehicular accident for each mode. NTSB may use the NRC telephone report information to help determine whether to proceed with its own investigation.

An NTSB investigation includes a multiple-day field investigation involving the shipper, carrier, government agencies, associations, and other interested parties. The investigations take place over several months, so that the full impact of the accident can be assessed. One consequence of this timeframe is that the accident damages reported by NTSB are substantially greater than those reported by carriers

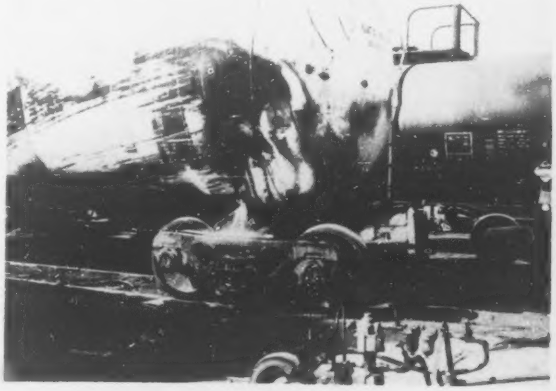

Photo credit: National Transportation Safety Board

In the course of an investigation, NTSB examines the deformation of the vehicle caused by the accident.

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[72] National Highway Traffic Safety Administration, *National Accident Sampling System (NASS), Analytical User's Manual* (Washington, DC: 1981).

[73] National Highway Traffic Safety Administration, *Fatal Accident Reporting Systems (FARS), User's Guide* (Washington, DC: August 1981).

Table 2-10.—Incident/Accident Databases

Database	Kept by	Years	Modes	Accidents	Incidents	Exclusive hazardous materials focus	Exclusive transport focus
Hazardous Materials Information System	DOT, Office of Hazardous Materials Transportation, Research and Special Programs Administration	1971 to present	All	Yes	Yes	Yes	Yes
Commercial Vessel Casualty File	U.S. Coast Guard	1963 to present	Marine	Yes	No	No	Yes
Pollution Incident Reporting System	U.S. Coast Guard	1971 to 1985	All	Yes	Yes	Yes	No
Truck Accident File	DOT, Bureau of Motor Carrier Safety, Federal Highway Administration	1973 to present	Highway	Yes	No	No	Yes
Railroad Accident File	Association of American Railroads	1973 to present	Rail	Yes	Yes	No	Yes
Air Accident File	Federal Aviation Administration	—	Air	Yes	Yes	No	Yes
National Accident Sampling System	National Highway Traffic Safety Administration	1983 (Hazardous materials flags added in 1983)	Highway	Yes	No	No	Yes
Fatal Accident Reporting System	National Highway Traffic Safety Administration	1983 (Hazardous materials flags added in 1983)	Highway	Yes	No	No	Yes
National Response Center	U.S. Coast Guard	—	All	Yes	Yes	Yes	No
National Transportation Safety Board File	National Transportation Safety Board	—	All	Yes	No	No	Yes
U.S. Department of Energy Data Base	Sandia National Laboratories	1979 to present	All	Yes	Yes	Yes	Yes
Washington State Accident File	Washington State Utility and Transportation Commission	1978	Highway	Yes	No	No	Yes

SOURCE: Office of Technology Assessment.

to RSPA.[74] NTSB maintains a database on the vital statistics of each investigated accident. Railroad and aviation accident data are stored in computer files. Highway and marine accident data are stored on coding sheets, but have not yet been logged into the computer system.

Department of Energy.—At the Sandia Laboratories, DOE maintains an online database on all radioactive incidents, based on the HMIS file and information from the Nuclear Regulatory Commission on the loss of control of radioactive materials. The database consists of approximately 70 percent HMIS records and 30 percent NRC records. NRC is the lead agency in conducting investigations of transport accidents involving radioactive materials. These investigations focus on mechanical analyses of the containers involved in the accident, for the purpose of improving the safety of the containers.[75] Table 2-2 presents a summary of these databases.

State and Local Agency Accident Data Systems

Accident and spill databases maintained by State and local agencies vary considerably depending on the authorities involved and the level of commitment the organization has made to managing hazardous materials transportation problems.

The most difficult data-gathering problem in State and local studies has been obtaining reliable information on past hazardous materials releases. Most fire departments do not keep separate records of hazardous materials incidents, although fire departments in some large metropolitan areas are beginning to develop special hazardous materials report forms for use in internal planning. State and local planners usually must rely on outside sources, some of which may be unreliable or contradictory. The experience of San Francisco Bay Area planners illustrates the difficulty of collecting data on releases: of 16 Federal, State, regional, and local sources contacted, only 9 could provide data on past releases within the timeframe requested for the study. Moreover, these sources did not have a common format, and sources reporting the same incident often varied considerably.[76] The staff conducting a current California study for the State legislature found it necessary to consult three separate databases to develop a reliable release record for the State highway system.[77]

State and local agencies have concentrated on developing accident reporting systems rather than release reporting systems and focus much of their attention on the highway mode. This is due to the role of the State and local police in reporting traffic accidents, and a well established and coordinated network of accident management.[78] There have, however, been several State and local attempts to focus on hazardous materials releases, many of them funded by DOT as demonstration projects.*

Other State and regional projects have explicitly examined hazardous materials releases, but have relied heavily or exclusively on HMIS for their data. These include an analysis of hazardous materials transport by rail conducted by the State of New Jersey[79] and a multimodal study of the transportation of hazardous materials in the New York-New Jersey region.[80]

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[74] U.S. General Accounting Office, *Programs for Ensuring the Safe Transportation of Hazardous Materials Need Improvement* (Washington, DC: November 1980).

[75] Lawrence Livermore National Laboratory, *Mechanical Analysis of a Transportation Accident Involving Empty Shipping Casks for Radioactive Materials Near Hilda, South Carolina in November 1982*, NUREG/CR-3452 (Washington, DC: U.S. Nuclear Regulatory Commission, October 1983); Lawrence Livermore National Laboratory, *Simulation of Loading Conditions for a Type A Package Containing Americium-241 Involved in an Airplane Crash at Detroit Metro Airport in January 1983*, NUREG/CR-3536 (Washington, DC: U.S. Nuclear Regulatory Commission, January 1984); Lawrence Livermore National Laboratory, *A Highway Accident Involving Radiopharmaceuticals Near Brookhaven, Mississippi, on December 3, 1983*, NUREG/CR-4035 (Washington, DC: U.S. Nuclear Regulatory Commission, April 1985); SRI International, *Mechanics of a Highway Accident at Wichita, Kansas, Involving Natural Uranium Concentrate*, NUREG/CR-0992 (Washington, DC: U.S. Nuclear Regulatory Commission, August 1979).

[76] Association of Bay Area Governments, "Issues and Recommendations," *San Francisco Bay Area: Hazardous Spill Prevention and Response Plan*, vol. 1 (Washington, DC: U.S. Department of Transportation, Research and Special Programs Administration, February 1983).

[77] Linda Turnquist, Analyst, California Transit (CALTRANS), personal communication, March 1986.

[78] Some States have mandatory reporting of hazardous substance releases similar to CERCLA requirements although many local agencies are unaware of these reporting requirements. See ICF, Inc., *Economic Analysis of Reportable Quantity Adjustments Under Sections 102 and 103 of the Comprehensive Environmental Response, Compensation, and Liability Act* (Washington, DC: March 1985).

*An additional Federal initiative has been the State Hazardous Materials Enforcement Development (SHMED) program. The focus has been on establishing uniform transportation safety standards for hazardous materials and the enforcement of these standards.

[79] New Jersey Department of Transportation, Office of Freight Services, *Movements and Incidents of Hazardous Materials in New Jersey* (Trenton, NJ: The New Jersey State Legislature, December 1984).

[80] Scanlon, op. cit.

More sophisticated State applications include the use of computerized accident recordkeeping systems used with flow data to determine highway accident rates and high risk locations. The States of Utah, Washington, and New York, for example, maintain computerized accident recordkeeping databases that contain police accident investigation reports. When a heavy truck is involved, the carrier name, vehicle type, contributing circumstances, accident severity, and other information are required. In the case of the State of Washington, the United Nations number of the cargo is also included.

This type of database permits extracting information about heavy vehicle accidents where hazardous cargo was involved. The information can be checked against movement data to determine accident rates of vehicles transporting hazardous cargo. The accident rates can be used subsequently to compute transport risk profiles and identify safer routes for hazardous materials. The capability to do this exists in the States of Washington and New York, but has not been utilized by the States, partly because of the fragmentation of State government responsibilities. Accident and movement data reside in different offices, and still other offices are responsible for policy analysis. Both States are, however, moving toward conducting better analyses of the data that is collected and maintained.

The State of Maryland has largely overcome these problems. Several years ago, Maryland began a surveillance system of hazardous cargo movements at multiple check points and different times of the day. A State release reporting system was also instituted under which any hazardous materials release is entered into the database. These two sources of information are subsequently compared to determine the level of hazardous materials transport safety in the State. This information has been used to demonstrate a preferred nuclear materials routing system in Maryland. However, the accomplishments in Maryland have come only after 10 years of activity and significant coordination among State agencies, demonstrating how time-consuming and painstaking such a process is.

State data-collection capabilities will be further enhanced when an integrated Federal-State data network, known as SAFETYNET, is made operational by BMCS. SAFETYNET will tie together the present BMCS Motor Carrier Safety database with HMIS and various computer-based State systems. The Motor Carrier Safety database now contains information on more than 200,000 interstate carriers and 30,000 hazardous materials shippers. It can report all of the known carriers domiciled in a region, rank them by the average number of driver and vehicle violations found per inspection, list the number of truck inspections each carrier has undergone, and give the date of the most recent safety audit. Once SAFETYNET is operating, BMCS and participating States should be able to:

- input driver-vehicle inspection data,
- update and query inspection data,
- update and query carrier census data,
- query safety management audit summary data,
- query accident report summary data,
- query inspection workload data, and
- generate system reports.[81]

A demonstration program involving four States—North Carolina, Colorado, Oregon, and Michigan—is in progress. The eventual goal is to include all States in SAFETYNET, but this may take 10 years or more to accomplish. Funding is to be provided through a variety of Federal and State programs.

Carrier Release Data

Virtually all carriers retain copies of reports on accidents and releases that they have filed with the appropriate authorities. However, OTA contractors found, based on conversations with carriers, that the methods used for reporting information on Form F5800.1 are arbitrary. There was a consensus among carriers that the primary purpose of the form is to record a release, not to establish accurate details, and that the 15-day reporting requirement is too short. For example, relatively small damage is often reported as no damage; when the damage is measurable, the carriers usually report the out-of-pocket cost and include the loss of cargo only and not the cleanup cost. There is little evidence that carriers use the release reports for any purpose beyond fulfilling the reporting requirement. Carriers also emphasize that it is inappropriate for them to be required to report releases that occur during loading and unloading, since they often do not perform this function and are unaware of a release having occurred or the details concerning it.*

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[81] J.A. Reyes Associates, Inc., "SAFETYNET: The Motor Carrier Safety Information Network," prepared for the U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, unpublished typescript, November 1984.

The Association of American Railroads maintains its own release database from inspector, railroad, Form F5800.1, CHEMTREC, and telephone reports. Information includes date, location, release type, source of data, deaths and injuries, and estimated damage. The damage estimates can be segmented by equipment, lading, fire, and other damage. The AAR database goes back to 1973.

Completeness and Accuracy of HMIS

The HMIS database is extremely important as the basis for most studies of hazardous materials transport safety in the United States. To assess the adequacy of HMIS for this purpose OTA addressed two concerns:

1. nonreporting of spills as documented in other databases that allow identification of hazardous materials releases, and
2. misreporting of spills as documented by information on the same incident in other release and accident databases.

To document the extent of nonreporting and misreporting, OTA contractors compared the HMIS database with relevant secondary databases on releases and accidents. However, in most cases, other reporting systems cover a much broader spectrum of releases and accidents than simply hazardous materials transport, and are thus not oriented for analyses of the industry at the level of detail theoretically available in the HMIS database. Moreover, databases differ on the definition of a reportable release. Despite these difficulties, **OTA concludes that analysis of secondary data is essential to ensure adequate records.**

At OTA's request, contractors undertook additional analysis to provide further documentation and develop estimates of nonreporting for HMIS keeping in mind that reports to HMIS of injuries and deaths are required only if the release occurs during interstate transportation and if damage is due to the hazardous material. The methodology for this effort was to match accidents with possible releases in secondary databases, such as NTSB and the BMCS Truck Accident File (TAF) with reported incidents in the HMIS database. Those releases for which an HMIS report could not be identified were included in the computation of nonreporting bias.

Misreporting estimates were developed by studying releases in the HMIS database for which the information reported by the carrier is inconsistent with information available in other reports for the same incident. The methodology used to address this issue is based on comparing reported consequences for matching releases.

The **Coast Guard's Commercial Vessel Casualty File** reporting criteria are detailed earlier in this report. While CVCF criteria differ somewhat from those for HMIS, they reflect similar objectives, including release consequence. While CVCF does not explicitly identify the vessel's cargo, it does have a detailed vessel-type definition from which releases likely to involve hazardous materials can be identified. For the purposes of this analysis, tanker ships and tanker barges were considered. A direct comparison between CVCF and HMIS was conducted for the period 1976-80.

CVCF analysis shows that collisions and groundings constitute the bulk of reported incidents, with relatively few releases caused by fire, explosion, or material failure. The primary cause of failure is most often "fault of other vessel/personnel." Inclement weather has a relatively minor impact on the overall number of reported incidents. (See table 2-11.) The most frequent general locations of marine hazardous materials releases were along the Gulf of

Table 2-11.—Waterborne Incidents Reported to the Commercial Vessel Casualty File by Primary Cause, 1976-80

	Number of incidents	Percentage of total
Poor weather	208	3
Equipment failure	502	8
Depth less than charted	138	2
Fault of other vessel/ personnel	4,240	69
Other	1,066	17
Total	6,154	

SOURCE: Office of Technology Assessment

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*This point was emphasized by Cynthia Hilton, Manager, The Chemical Waste Transportation Council, personal communication by letter, May 20, 1986.

Mexico, probably reflecting the major petroleum and chemical activities in that region. (See table 2-12.) This contrasts greatly with the HMIS analysis, which lists high frequency marine release locations as Louisiana, California, New Jersey, Puerto Rico, and Maryland.

A comparison of CVCF release reports and consequences with marine releases contained in the HMIS database appears in table 2-13. The number of reportable releases is off by a factor of 41; over four times as many injuries have been reported to CVCF; 24 deaths have been reported to CVCF, with no fatalities listed in HMIS. However, because of the format of the CVCF report, it is impossible to determine if the injury or death was due to the hazardous material or some other cause, such as collision forces. The average damage per release is four times greater in CVCF, implying that the procedures used in CVCF reporting acknowledge more substantial destruction than reported by carriers to RSPA. For the period 1976-80, damage apparently related to hazardous materials releases reported to CVCF exceeds $189 million, or over $50 million more than the damage total in HMIS for 1976 to 1984 on all transport modes combined.

Truck Accident File.—The BMCS Truck Accident File includes all reported vehicular accidents involving hazardous and nonhazardous cargo. Three common descriptive fields exist for HMIS and TAF: year, month, and State of release. Thus, an HMIS incident occurring at a different location in the State or on a different day during the same month might be erroneously matched; hence, the nonreporting estimate from this analysis should be considered a lower bound. A data field within the database permits isolation of accidents involving vehicles carrying hazardous materials. Table 2-14 identifies the States where data for 1983 showed that accidents occurred most frequently. The top five States from the RSPA database are Pennsylvania, Ohio, Illinois, New York, and Texas, respectively. Although most of the same States appear at the top of both the TAF and HMIS databases, the order is not the same. Table 2-15 displays the TAF-reported injuries and deaths for 1983. The impact to the community—the number of other people killed and injured as a consequence of a hazardous materials accident—dwarfs the impact to the driver and other riders.

Table 2-12.—Waterborne Incidents Reported to the Commercial Vessel Casualty File by General Location, 1976-80

Inspection unit	Number of incidents	Percentage of total
New Orleans	1,065	17
New York	516	8
Galveston	424	7
Paducah	359	6
Memphis	357	6
Houston	331	5
Port Arthur	324	5
Mobile	300	5

SOURCE: Office of Technology Assessment.

Table 2-13.—Commercial Vessel Casualty File (CVCF) Comparison With the Hazardous Materials Information System (HMIS) Database, 1976-80

	CVCF	HMIS database
Number of incidents	6,154	150
Injuries	57	13
Deaths	24	0
Average damage per incident ($)	$30,817	$7,843

SOURCE: Office of Technology Assessment.

A comparison of TAF and HMIS statistics for 1983 appears in table 2-16. The databases contain information on 502 matching incidents, the consequences of which appear in tables 2-17 and 2-18. Carrier-reported incidents underestimate the deaths, injuries, and damages associated with hazardous ma-

Table 2-14.—Truck Accidents by General Location Using the Truck Accident File, 1983

State	Number of incidents	Percent of total
Texas	152	9.5
Pennsylvania	107	6.7
New York	79	4.9
California	79	4.9
Ohio	66	4.1

SOURCE: Office of Technology Assessment.

Table 2-15.—Truck Accident File Reported Injuries and Deaths, 1983

	Deaths	Injuries
Driver	28	474
Relief driver	2	38
Authorized rider	2	62
Unauthorized rider	2	8
Others	120	897
Total	154	1,479

SOURCE: Office of Technology Assessment.

Table 2-16.—Truck Accident File (TAF) Comparison With Hazardous Materials Information System (HMIS) Database, 1983

	TAF	HMIS database
Number of vehicular accidents	1,602	approx. 211[a]
Injuries	1,479	max. 121[b]
Deaths	154	max. 8[b]
Average damage per accident	$16,800	approx. $1,534[c]

[a] Approximation is based on the total highway incidents for 1983 multiplied by the percentage of incidents which are result of vehicular accidents (4.5%).

[b] These numbers are 1983 totals for all accidents *and* incidents.

[c] This is the average reported damage per incident for 1983.

SOURCE: Office of Technology Assessment.

Table 2-17.—Hazardous Materials Information System (HMIS) Misreporting Consequences Using the Truck Accident File (TAF) Databases, 1983

	Number of matching incidents	Deaths	Injuries	Damages
TAF	502	50	490	$10,077,004
HMIS	502	5	59	4,404,092

SOURCE: Office of Technology Assessment.

Table 2-18.—Hazardous Materials Information System (HMIS) Misreporting Consequences Using the National Response Center (NRC) Database, 1983

Mode	Number of matching incidents	Deaths NRC	Deaths HMIS	Injuries NRC	Injuries HMIS
Air	1	0	0	0	0
Rail	243	4	0	21	42
Highway	449	16	6	117	23
Water	1	0	0	0	0

SOURCE: Office of Technology Assessment.

terials transport incidents. Approximately 8 times as many vehicular accidents involving hazardous materials were reported to TAF as to HMIS, resulting in at least 12 times as many injuries and 19 times as many deaths. Finally, the average damage per incident is considerably larger for the TAF database. This can be partially explained by the facts that the HMIS estimate includes other releases, which may be less destructive, than those related to accidents and that damages reported to HMIS are estimated based on the consequences of the hazardous material involved only.

Despite the loosely matching criteria, of the 1,602 hazardous materials accidents appearing in TAF, **only 502 or 31 percent could be found in the HMIS database.** The missing accidents caused a combined impact of 104 deaths, 989 injuries, and $16,867,056 in damages. Among the more notable nonreported accidents are the following: Highland Park, Illinois, on March 22, 1983, killing one, injuring four, and causing $120,000 in damages; Kemmerer, Wyoming, on April 7, 1983, killing five, injuring two, and causing $26,500 in damages; Georgetown, Kentucky, on May 1, 1983, killing three, injuring nine, and causing $75,000 in damages; and Hurricane, Utah, on November 21, 1983, killing three, injuring three, and causing $100,000 in damages.

National Response Center.—This database is not designed for policy analysis purposes; however, some limited relevant analyses can be conducted. Reports to NRC could include hazardous substance spills, which EPA requires be reported but RSPA does not, unless the substance is specifically listed in the Hazardous Materials Table.

The matching methodology consisted of searching on four common fields: year, month, day, and State of incident; the results are shown in table 2-19. Table 2-20 displays NRC and HMIS statistics for numbers of reported incidents, deaths, and injuries in 1983. In total, NRC-reported injuries and deaths are significantly larger than those reported in the HMIS database, although there is considerable fluctuation at the modal level. The data dem-

Table 2-19.—Hazardous Materials Information System (HMIS) Nonreporting Consequences Using the National Response Center Database, 1983

Mode	Number not found in HMIS database	Percentage nonmatching	Deaths	Injuries
Rail	510	68	2	10
Highway	431	49	12	72
Air	11	92	1	0
Water	552	99	0	29

SOURCE: Office of Technology Assessment.

Table 2-20.—Hazardous Materials Information System (HMIS) Nonreporting Analysis Using the National Transportation Safety Board (NTSB) Database, 1976-83

Mode	Number of incidents in NTSB database	Number not found in HMIS database	Percentage nonmatching
Rail	258	165	64
Highway...	6	3	50
Water	7	6	86

SOURCE: Office of Technology Assessment.

Table 2-21.—Hazardous Materials Information System (HMIS) Nonreporting Consequences Using National Transportation Safety Board Database, 1976-83

Mode	Number not found in HMIS	Deaths	Injuries	Damages
Rail	165	37	92	$89,443,936
Highway....	3	12	41	125,000
Water	6	13	18	16,360,000

SOURCE: Office of Technology Assessment.

onstrate serious nonreporting problems for the air transport industry. The NRC database has limited usefulness in quantifying damage estimates, since this is not a reporting requirement. Table 2-19 shows the results of comparisons between the databases for matching incidents; valid comparisons can be made only for the rail and highway modes.

The **National Transportation Safety Board** examines only hazardous materials incidents that have serious consequences; thus theoretically, all NTSB incidents should also have been reported to RSPA and included in HMIS. NTSB incident reports include information on injuries, deaths, and damages, and share five matching fields with HMIS: year, month, day, city, and State. HMIS files for 1976 to early 1983 were studied to find information matching NTSB data; the results are shown in table 2-20. **The analysis indicates that 50 percent or more of the most serious hazardous materials transport incidents go unreported to RSPA.** OTA did not attempt to determine whether this percentage changed over time. Most NTSB hazardous materials reports for which sufficient information was available were for rail incidents, and nearly two-thirds of NTSB incidents were not reported in HMIS.

Table 2-21 displays the consequences of the unreported incidents. For rail alone, the injuries and damages of unreported incidents appearing in the NTSB database exceed the total reported injuries and damages for all HMIS rail incidents from 1976 to 1984. Among the more notable omissions are an incident in Maryland, Oklahoma, on December 15, 1976, which resulted in 3 deaths, 11 injuries, and an estimated $880,700 in damages; Crestview, Florida, on April 8, 1979, which injured 14 people and caused $1,258,500 in damages; Pisgah, California, on May 11, 1980, which killed 1 person, injured 3, and caused $2,889,000 in damages; and Benton, Iowa, on August 15, 1982, which injured 1 and caused $2,140,000 in damages.

Although the sample size for highway and marine is too small for good analysis, in two other modes NTSB showed serious incidents that were not reported to HMIS. For example, a highway incident on December 28, 1977, in Goldonna, Louisiana, which killed 2 people, injured 11, and caused $125,000 in damages, and a marine incident in Good Hope, Louisiana, on August 30, 1979, which killed 12 and resulted in $10,500,000 in damages were not reported to HMIS. (See table 2-17.)

Examples of misreporting include a rail release in Newton Falls, Ohio, on May 9, 1979, that caused an estimated damage of $1,407,000 in the NTSB report; according to the HMIS database, no damage was reported. In another case, NTSB reported $2,540,000 in damages caused by a rail release in Hastings, Iowa, on July 10, 1980; the HMIS report shows no damage.

NTSB reviews the incidents it investigates over an extended period of time and holds discussions with a number of involved and affected parties. In contrast, RSPA requires reports to be submitted by the carrier within 15 days of the incident. Table 2-22 displays the consequence statistics of NTSB and HMIS for matching incidents. For the rail mode, RSPA estimates of death and injury are within range of NTSB reports. However, damage estimates are off significantly, by a factor of 7 to 8.

The Association of American Railroads Database.—AAR maintains a hazardous materials incident file that includes a data field identifying the primary source of the report. AAR data corroborate the results of the HMIS comparison with NTSB data; over 60 percent of reportable rail releases are not being reported to RSPA. Of 13,706 incidents

Table 2-22.—Hazardous Materials Information System (HMIS) Misreporting Consequences Using the National Transportation Safety Board (NTSB) Database, 1976-83

Mode	Number of matching incidents	Deaths		Injuries		Damages	
		NTSB	HMIS	NTSB	HMIS	NTSB	HMIS
Rail	93	33	28	192	315	$62,589,360	$8,437,363
Highway	3	11	11	21	8	138,070	2,119,820
Water	1	9	0	0	0	0	0

SOURCE: Office of Technology Assessment.

examined in the file, the primary sources were reported as follows:

Inspector	3,356	(24 percent)
Railroad	365	(3 percent)
Telephone	834	(6 percent)
CHEMTREC	1,901	(14 percent)
Unknown	1,978	(14 percent)
Form F5800.1	5,272	(38 percent)

Washington State Accident File (WSAF).—WSAF is maintained by the Washington Utilities and Transportation Commission. OTA contractors examined this database because, while it includes all highway freight accidents, it also contains a unique identifier for accidents involving hazardous materials. Moreover, this database has useful information not available in HMIS records, such as location type (urban/rural), type of accident, road surface, light conditions, type of road, truck contributing circumstances, truck driver/vehicle actions, truck vehicle condition, and truck driver sobriety.

Data from 1984 show the following: the locations of hazardous materials accidents were split evenly between rural and urban sites. Two-thirds of the accidents were property damage only, with very few showing major property damage. One-third of the accidents occurred on roads that were wet, icy, or covered with snow. Nearly three-quarters of the accidents occurred in daylight. Roughly 85 percent of the accidents occurred on two-lane or four-lane roads, in contrast to 12 percent at intersections. **Eighty percent of the accidents involved flammable liquids.** Of the 331 reported accidents, only 11.5 percent resulted in a reported spill. Not including "no contributing circumstances," "driver inattention" was cited as the most frequent contributing factor. Roughly 70 percent of the accidents occurred while the vehicle was being driven along a straight path, followed by right and left turns at 8 and 6 percent, respectively. In over 80 percent of the accidents, the vehicle had no cited defect. Finally, driver drinking causing impairment was cited only once.

Spills contained in WSAF were compared to HMIS to explore the issues of nonreporting and misreporting. Only 58 of 331 records, or 18 percent, were found in the HMIS database. For those records that matched, HMIS reported no deaths, no injuries, and $438,894 in damages, in contrast to 2 deaths, 22 injuries, and $956,370 reported in WSAF.

These findings raise serious questions about the integrity of the RSPA reporting system both for unreported incidents and inaccurately reported incidents.

The problem of underreporting in HMIS is most serious for marine incidents, as indicated by NTSB, the National Response Center, and CVCF data; moreover, based on more limited NRC data, underreporting of air incidents is also high. The number of reportable incidents may be underestimated by factors of at least 10 and 20, for air and water, respectively. For highway and rail transport, the number of reportable incidents may be underestimated by factors of at least 2 and 3, respectively. Furthermore, major events, resulting in deaths, injuries, and significant damage, have gone unreported to DOT. Misreporting creates underestimates of damages more than of deaths and injuries.

When the nonreporting and misreporting estimates for each mode are applied as multipliers to HMIS incident and damage estimates, HMIS reports for 1976 to 1984 of 79,257 incidents resulting in $144,751,240 in damage should be adjusted to 178,683 incidents resulting in $1.47 billion in damage, according to OTA calculations. This analysis indicates a more serious safety problem than is presently acknowledged by DOT and lends credence to the concerns voiced by State and local officials.

HMIS Uses

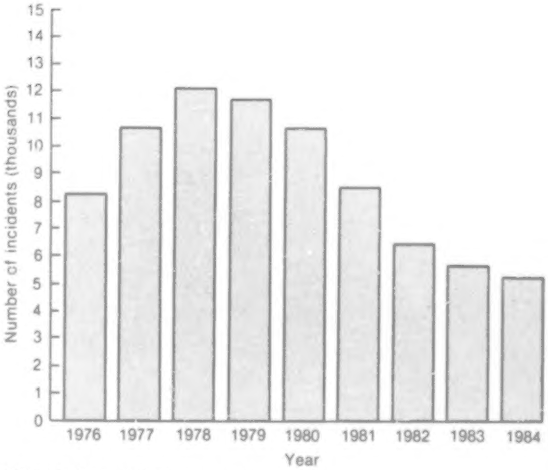
The underreporting in HMIS makes it of questionable value for some types of analysis. However, it provides the best data available on container problems. When matched against rudimentary commodity flow data, several conclusions useful for helping to make management decisions can be drawn. Conversely, many issues simply cannot be resolved even by the most painstaking analysis, because too many questions remain unanswered. A review of the possible uses of HMIS follows.

For the 9-year period studied by OTA, the total number of incidents by year reported to HMIS was 79,253. As figure 2-3 shows, a general increase in reported incidents occurred through the late 1970s, even after changes in reporting requirements, followed by a significant decline beginning in 1980. However, because there is no similar annual commodity flow data, it is impossible to establish whether incident rates have dropped, perhaps indicating a safer system, or whether the number of movements has decreased, resulting in similar or worse incident rates. It is also possible that nonreporting has increased or that the loosening of reporting requirements in 1981 led carriers to assume that they need not report any small spills.

Table 2-23 displays the results of a study of incident location by mode. Heavy concentrations of incidents occur in Pennsylvania, Ohio, Illinois, Texas, and California, probably due to major industrial activity and significant truck and rail corridors of travel for materials destined for other States. So few marine releases are reported to HMIS that no conclusions can be drawn about water transport. Tennessee is the most frequent site for air incidents, probably because Memphis is a major air freight hub.

Human error is the primary cause of 62 percent of incidents, followed by package failure, and vehicular accidents. (See figures 2-4 and 2-5.) The more specific reasons for incident occurrence appear in table 2-24. The predominant cause of failure varies considerably by mode, although external puncture and loose and defective fittings are often reported. These problems frequently occur during loading or unloading operations or when cargo shifts during transport, resulting in container bottom, body, or side failure, often caused by damage from other freight.

Figure 2-3.—HMIS Incidents by Year



SOURCE: Office of Technology Assessment.

These conclusions point to issues that deserve recognition and either further study or development of countermeasures. For example, public information programs to reduce the likelihood of hazardous materials being shipped by parcel post as baggage might be undertaken by the Postal Service and the airlines. Thorough analysis of loading, unloading, blocking, and bracing operations and procedures is needed for all modes, but especially for truck, rail, and air. Standard procedures and industry training programs could be developed.

The analyses also identified several other problems in the industry deserving recognition and resolution. The use and integrity of MC-306 tank trucks and trailers for the highway mode, 111A tank cars for the rail mode, and 17E containers* warrant further examination, especially those used to carry corrosives, which OTA's analysis shows have the highest incident rate of all commodities. Finally, the condition of containers involved in incidents and the frequent use of nonspecified or unauthorized containers suggest the need for improved governmental inspection and enforcement activities. On the other hand, HMIS data show that vandalism and terrorism have not been serious problems.

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*17Es are the most commonly used metal drum or pail container types.

Table 2-23.—Number of Incidents[a] by Location and Mode, 1976-84

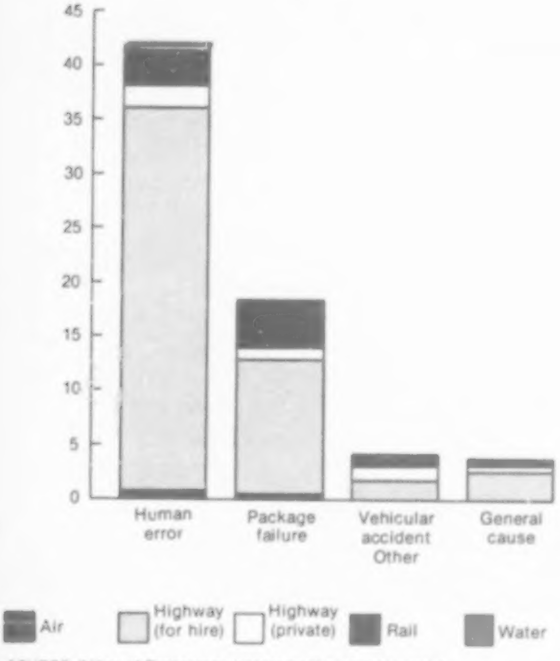
	Mode							
State	Air	Highway (for hire)	Highway (private)	Rail	Water	Freight forwarder	Other	Total
Alabama	4	1,269	67	**410**[b]	—	5	—	1,755
Alaska	23	35	8	4	8	—	1	79
Arizona	8	934	59	262	—	—	2	1,265
Arkansas	—	1,170	25	251	—	—	2	1,448
California	**76**	2,470	**430**	**817**	**15**	3	**22**	**3,833**
Colorado	34	1,119	52	73	—	—	2	1,280
Connecticut	4	383	53	16	—	—	—	456
Delaware	—	171	27	68	—	2	—	268
District of Columbia	3	71	38	2	—	—	—	114
Florida	20	1,676	89	**518**	2	2	1	2,308
Georgia	16	2,331	41	334	2	2	3	2,729
Hawaii	9	6	12	—	1	1	—	29
Idaho	—	149	28	60	—	—	1	238
Illinois	**49**	**3,340**	125	**828**	—	8	3	**4,353**
Indiana	5	2,155	76	189		5	1	2,431
Iowa	3	1,110	27	95	—	—	2	1,237
Kansas	—	1,167	44	166	—	2	3	1,382
Kentucky	7	799	135	169	—	—	2	1,112
Louisiana	13	1,101	84	372	**22**	3	**14**	1,609
Maine	—	68	11	44	—	—	1	124
Maryland	10	1,105	134	45	**9**	2	5	1,310
Massachusetts	16	832	80	88	2	5	2	1,025
Michigan	17	2,274	114	254	—	7	5	2,671
Minnesota	13	1,213	44	99	—	—	1	1,370
Mississippi	—	823	47	90	—	1	3	964
Missouri	14	2,518	101	143	1	4	1	2,782
Montana	1	205	27	72	—	—	1	306
Nebraska	3	719	7	51	—	1	1	782
Nevada	3	106	11	17	—	—	—	137
New Hampshire	—	55	9	9	—	—	1	74
New Jersey	11	1,604	109	180	**14**	**11**	8	1,937
New Mexico	4	717	38	94	—	—	—	853
New York	**56**	**3,133**	**210**	211	7	5	**14**	3,636
North Carolina	5	2,408	54	235	1	5	**10**	2,718
North Dakota	—	55	28	18	—	—	—	101
Ohio	16	**4,804**	**143**	328	—	**14**	8	**5,313**
Oklahoma	12	645	50	46	—	1	—	754
Oregon	4	355	59	165	—	—	—	583
Pennsylvania	28	**6,473**	**245**	322	3	**34**	4	**7,109**
Puerto Rico	4	4	3	—	**12**	1	1	25
Rhode Island	—	107	13	3	—	—	—	123
South Carolina	4	1,351	33	108	5	2	3	1,506
South Dakota	—	84	16	5	—	—	—	105
Tennessee	**337**	2,478	73	203	2	3	1	3,097
Texas	**48**	**2,642**	212	**1,265**	6	4	**14**	**4,191**
Utah	1	494	27	16	—	1	—	539
Vermont	—	34	16	2	—	—	1	53
Virginia	3	1,671	67	124	7	4	5	1,881
Washington	13	812	121	133	7	5	2	1,093
West Virginia	1	471	43	65	—	1	—	581
Wisconsin	6	1,975	49	56	—	—	1	2,087
Wyoming	1	211	51	60	—	1	2	326

[a] Incidents refers to the number of hazardous materials releases. For highway transport, a report is required only for releases that occur to a company engaged in interstate transportation.

[b] Boldface numbers indicate five States with the highest number of incidents for each category.

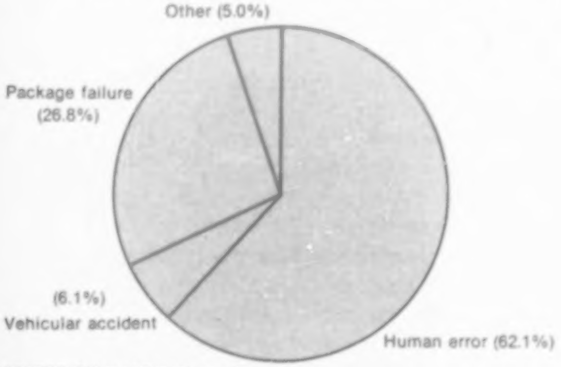
SOURCE: Office of Technology Assessment.

Figure 2-4.—General Causes of Spills by Mode According to the HMIS



SOURCE: Office of Technology Assessment contractor report.

Figure 2-5.—General Causes for All Modes



SOURCE: Office of Technology Assessment.

Despite the fact that several years of data can be examined, catastrophic events are rare enough that a single release in a given mode, hazard class, or container category, can distort the analysis of particular segments of the industry. More complete data might provide a more balanced picture, despite this problem, and would permit using release reports as a management tool.

Conclusions

HMIS was the subject of considerable criticism in 1980 from the U.S. General Accounting Office (GAO) for the following reasons:[82]

1. RSPA is not receiving reports on all spills because it relies on voluntary reporting from carriers;
2. companies involved only in the loading, unloading, or storage of hazardous materials (e.g., shippers and freight forwarders) are not required to submit hazardous materials incident reports;
3. reports are not required by RSPA for spills involving hazardous materials shipped in bulk by water;
4. DOT has elected not to require firms involved only in intrastate transportation to submit hazardous materials spill reports;
5. RSPA has no systematic procedure for refining reported data that are incomplete or inaccurate; and
6. the total consequences of spills are understated significantly due to the time limit on reporting and soliciting solely the carrier's perspective.

Each of these factors works to understate the overall impact of hazardous materials transportation releases. **OTA finds that the database deficiencies noted in the GAO report persist and that the total volume of hazardous materials releases is seriously underestimated. Moreover, the value of HMIS for deriving distributions of events, causes, and consequences, and multimodal comparative analyses is questionable. OTA finds that improvements to the RSPA incident reporting system are needed to ensure more accurate and comprehensive diagnostic and evaluative studies of hazardous materials transportion safety.**

The major areas for improvement include:

- initiatives to ensure complete reporting of hazardous materials releases,
- coordinated working agreements between RSPA and other governmental agencies covering data

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[82] U.S. General Accounting Office, op. cit.

Table 2-24.—Cause of Failure by Mode, 1976-84

		Mode							
Number	Code	Air	Highway (for hire)	Highway (private)	Rail	Water	Freight forwarder	Other	Total
1	Dropped in handling	**239**[a]	4,334	95	30	16	18	11	4,743
2	External puncture	81	**12,051**	362	481	**39**	**56**	**35**	**13,105**
3	Damaged by other freight	62	**8,192**	53	146	8	**30**	7	8,498
4	Water damage	2	62	2	16	2	—	—	84
5	Damage from other liquid	2	69	1	5	—	—	—	77
6	Freezing	—	182	21	12	1	2	—	218
7	External heat	3	116	17	53	3	1	1	194
8	Internal pressure	57	666	113	399	19	1	4	1,259
9	Corrosion or rust	6	641	36	118	4	1	2	808
10	Defective fittings	60	3,375	321	**2,883**	**27**	2	18	6,686
11	Loose fittings	**257**	7,851	421	**3,684**	22	18	**29**	**12,282**
12	Failure inner receptacle	35	622	17	60	—	—	1	735
13	Bottom failure	24	3,780	66	76	4	7	3	3,960
14	Body/side failure	64	2,517	105	279	14	18	9	3,006
15	Weld failure	4	728	50	70	13	3	4	872
16	Chime failure	2	556	12	35	1	2	2	610
17	Other conditions	129	2,492	282	328	22	5	20	3,278
18	Hose burst	—	872	83	7	1	—	3	966
19	Load/unload spill	2	5,985	**1,283**	72	2	—	9	7,353
20	Cargo shifted/fell	30	6,127	120	357	14	22	7	6,677
21	Improper loading	18	2,381	15	62	5	10	1	2,492
22	Vehicle accident	3	2,145	**972**	994	3	1	12	4,130
23	Venting	—	13	25	120	—	—	1	159
24	Release of fumes	3	46	9	147	—	—	2	207
25	Friction	1	101	8	17	2	2	—	131
26	Static electricity	—	8	—	2	—	—	—	10
27	Metal fatigue	—	531	4	12	1	1	—	549

[a] Boldface indicates top two causes of failure in each mode.

SOURCE: Office of Technology Assessment.

sharing and developing the capability to match release reports,

- development of software to identify misreporting and nonreporting, and
- additional data-entry/data-validation clerks and staff to ensure complete, accurate reports.

Moreover, the accuracy of DOT's Hazardous Materials Information System can be improved without large expenditures for technology improvements. For instance, Form F5800.1 does not clearly specify the data items RSPA attempts to collect from it. The carrier issuing the report is given considerable latitude in describing the incident; consequently, the data-entry staff must make subjective judgments on how the reports should conform to the HMIS record structure. RSPA is currently revising the form. In this process, questions on the form about cause, characteristics, and consequence should be structured so that the respondent selects specific entries from lists of potential choices, as in Part F (Nature of Packaging Failure) on the present form. This would create a uniform basis of reporting and decrease the redundant entries in the database, particularly for container types. Furthermore, it would make the data-entry process more efficient and provide a more concise database.

RSPA has expressed interest in condensing the information required on Form F5800.1, citing the cumbersome problem of managing a large historical database.[83] However, the amount of information now requested on Form F5800.1 is not excessive when contrasted with that for other reporting systems such as NASS, FARS, TAF, and CVCF. In comparison to other incident/accident databases, the volume and complexity of reports received annually by RSPA are relatively small.

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[83] "Detailed Hazardous Materials Incident Reports," *Federal Register*, vol. 49, No. 53, Mar. 16, 1984, pp. 10042-10047.

The data fields in the current HMIS database cover most of the major elements of a hazardous materials transport incident. However, additional information on the age and registration number of the vehicle, driver, weather conditions, cargo weight, type of event (e.g., in transit/loading/unloading), and package type (e.g., bulk/nonbulk) would be useful. Inclusion of the telephone number for the National Response Center on Form F5800.1 could remind the carrier to provide a telephone report if warranted.

Revising the criteria for requiring a written report has been recently proposed by RSPA.[84] Since most small package incidents have minor consequences, RSPA is considering a new reporting criteria for Form F5800.1 requiring its completion only if an incident results in any of the circumstances set forth in 49 CFR 171.15 or involves:

- bulk packagings,
- shipments aboard aircraft or in air terminals,
- property damage equal to or in excess of $1,000 including cleanup,
- evacuation,
- packages or hazardous materials under an exemption, or
- any quantity of hazardous waste that has been discharged during transportation.

Deleting the requirement for reporting smaller spills would deprive DOT of its primary source for evaluating small packages carried in less-than-load lots. See chapter 3 for a discussion of the impact of such a change on small packaging requirements.

The issue of the carrier's primary responsibility for notification of releases warrants examination. Possible changes include extending the reporting time limit to 30 days to encourage more complete evaluation of incident characteristics and consequences. Furthermore, shippers and receivers could be held responsible for reporting loading/unloading incidents, if RSPA develops a system to indicate possible redundant reports. Immediate telephone followup to obtain information missing from reports would permit complete data to be entered into the HMIS database. Finally, comparisons of HMIS reports to reports filed with other systems, such as NRC, CVCF, TAF, and NTSB, could identify discrepancies and identify nonreported incidents meeting HMIS reporting criteria.

These changes would require the cooperation of several agencies in furnishing data to RSPA and designing their reports with common data fields to permit direct comparisons. Although modifying reporting and database formats can be costly and time-consuming, two alternatives could make expensive changes unnecessary:

1. Conversion or bridge tables could be constructed to transform other agency data items into data items contained in the HMIS database so RSPA could conduct nonreporting analyses.
2. Data items required for matching could be added to other agency report forms and databases.

OTA finds that HMIS misses numerous releases recorded in other Federal databases, in part because bulk marine releases and those occurring during solely intrastate commerce need not be reported, and because the reporting requirement is not enforced. Furthermore, little effort is made to include data other than that reported on Form F5800.1 in RSPA's annual report, making the report an inadequate reflection of the safety of the transportation of hazardous materials.

Moreover, OTA analyses of flow and accident data indicate that relatively few of the HMIS data can be used as indicators. A major accident in any single year or on any mode can skew the data significantly. However, when combined, current Federal accident and spill databases can provide more complete information on the dimensions of hazardous materials transportation safety problems.

A California study, being conducted for the State legislature, compared three separate databases showing highway spills and determined that at least 500 spills occur annually on the State highway system alone, excluding the city streets. The study demonstrates that several databases must be used to generate reasonably complete data, even for a single State. These results show driver error as the single largest cause of spills and imply that concentration on addressing truck-related issues such as driver training and qualifications is essential for safety improvements.

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[84] Ibid.

The intent of the HMTA clearly indicates the need for an adequate annual summary of the safety of hazardous materials transportation, making improvement to HMIS an urgent issue. **OTA concludes that including bulk marine and intrastate releases in the HMIS reporting requirement and enforcing the requirement are important priorities. Increased cooperation and information sharing among DOT agencies, EPA, and State enforcement officials are also essential.** Congress could require DOT to extend accident reporting requirements to all hazardous materials spills whether they occur during interstate or intrastate transport and regardless of mode. A coordinated national spill reporting center, with reporting procedures and common data report fields that must be implemented by all Federal agencies, could be designated. Congress might wish to require display of a toll-free number for the national report center as the place to call for reporting accidents. DOT, NRC, or HMIS staff provide natural homes for this coordinating role. Moreover, if formats including common data fields were decided on, accident reports collected at the State level could be submitted periodically to the regional DOT or EPA office. The regional Federal offices would provide annual updates to the national center. Several regional EPA offices already work with the States in their regions and have good computerized reporting systems. Spill reports should be checked at the regional level for accuracy and completeness, before being submitted to the national data-collection center.

The annual DOT reports to Congress on the transportation of hazardous materials could be required to document accidents by State, container types, mode, and cause. Improvement of the RSPA spill report Form F5800.1 and coordination with modal administrations to develop common data fields that are less open to subjective interpretation could make the form reflect more accurately the causes and details of the spill.

Chapter 3

Containers for Hazardous Materials Transportation

Photo credit: Chemical Leaman

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Chapter 3

Containers for Hazardous Materials Transportation

INTRODUCTION

Ensuring the safe transportation of hazardous materials is a complex activity. If accidentally released, hazardous materials pose risks to human safety, property, and the environment. Consequently, the containers or packagings used for shipping most of these materials are required by regulation to be adequate to contain their contents during normal transport. However, standards for containers for highly radioactive materials are set differently and require that the packages withstand severe accident conditions without a dangerous radioactive release.

Over 30,000 different hazardous materials must be shipped under U.S. Department of Transportation (DOT) regulations. Among the classes of materials regulated are explosives, flammables, corrosives, combustibles, poisons, radioactive materials, and etiologic (disease-causing) agents. These materials, essential to the business and industrial economy of the United States, are shipped by air, highway, railroad, and water under regulations that reflect the history and different operating characteristics of the various modes. Hazardous products are transported in bulk by vessels, tank cars, tank trucks, intermodal portable tanks; and in smaller containers such as cylinders, drums, barrels, cans, boxes, bottles, and casks. Widely varying packagings have been developed by industry to match the strength and integrity of the containers to the characteristics and hazards of the materials they must contain.

Packaging for hazardous materials during transportation is a major element of DOT's regulatory system. The Department, through its Research and Special Programs Administration and other branches, establishes technical standards for the design and testing of packages and associated transportation equipment for all hazardous materials and small quantities of radioactive materials. The Nuclear Regulatory Commission (NRC) sets standards for the design and performance of packages to carry highly radioactive materials.* Private shipping companies and container manufacturers, DOT, NRC, and the Department of Energy (DOE), all are exploring new technologies and possible design changes for the shipping containers used for hazardous materials and wastes, including spent nuclear fuel. Packaging issues that repeatedly confront Federal agencies include:

- the types and severity of tests necessary for determining the level of protection provided by the packagings,
- the development of new materials for packagings,
- the influence of international commerce and standards on U.S. packaging designs, and
- the impact of accident and spill frequency and consequences on container regulation.

This chapter examines a wide range of issues concerning hazardous materials packaging technology, including the development of design and testing standards and their relationship to the transportation system. Part I examines the unique container issues associated with the transportation of radioactive materials, including those related to shipment of high-level radioactive wastes, such as spent nuclear fuel. Part II deals with packaging for other hazardous materials commonly used, such as chemicals, petroleum products, explosives, and poisons. It discusses:

- the present spectrum of bulk equipment and small packages for shipping hazardous materials and wastes, and
- the impact of Federal regulation on transportation safety and container technology.

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*Highly radioactive materials include fissile and greater than A_1 and A_2 limits of radioactive materials. Fissile material is that containing one or more fissile radionuclides—Plutonium 238, Plutonium 239, Plutonium 241, Uranium 233, and Uranium 235. Neither natural nor depleted uranium is fissile material. A_1 and A_2 quantity limits are defined in 10 CFR 71.4 and table A-1 thereto.

PART I: CONTAINERS FOR TRANSPORTING RADIOACTIVE MATERIALS

Radioactive materials are employed extensively in modern society. In addition to their role in generating electric power, radioactive materials are used for research, manufacturing, and a wide range of industrial processes. They are also often indispensable for medical diagnosis and therapy. The pervasive use of these materials means that they and any waste products must be regularly transported. In total, some 2.8 million packages of radioactive materials are transported in about 2 million shipments each year in the United States by truck, rail, and air, out of 100 million shipments of all types of hazardous materials. Box 3A defines terms used throughout this chapter.

Almost two-thirds of radioactive shipments are for medical purposes, with the balance for use in the nuclear fuel cycle to generate electricity, for industrial and research activities, and waste.* (See table 3-1.) About 7 percent of all shipments are classified as wastes (see box 3A), with the vast majority being low-level wastes.[1] The total volume of low-level wastes shipped each year is about 2.7 million cubic feet, or enough to cover a football field with a pile 52 feet high. Between 100 and 300 shipments of high-level wastes and spent fuel, from electric utilities, and DOE and U.S. Department of Defense (DOD) research or training facilities, are made annually by truck and rail. See tables 3-2 and 3-3 for histories of commercial reactor and low-level waste shipments, respectively, and table 3-4 for the volumes and types of shipments associated with the nuclear fuel cycle. Reactor operation and the fuel cycle are summarized in box 3B.

Box 3A.—Forms of Radioactive Wastes

Spent fuel.—Irradiated fuel discharged from a nuclear reactor. Contains fission products, unused uranium and plutonium, and various transuranic (TRU) elements.

High-level wastes.*—Highly radioactive materials resulting from chemical processing of spent fuel to recover usable uranium and plutonium. Contains fission products, traces of uranium and plutonium, and other TRU elements.

Transuranic wastes.—Materials contaminated with enough TRU elements to require the same sort of long-term isolation as high-level radioactive wastes. TRU elements are radioactive and have long half-lives; examples include plutonium and americium.

Mill tailings.—Slightly radioactive materials left over from extraction of uranium from ore.

Low-level wastes (LLW).—All radioactive wastes not classified as high-level radioactive wastes, TRU wastes, mill tailings, or byproduct materials as defined in Public Law 96-73. Fuel cycle LLW is generated from the conversion of yellowcake to UF_6 as well as reactor operations. LLW also is generated by institutions and industries engaged in research and various industrial and medical activities. While most LLWs are relatively short-lived and have low radioactivity, some may present a significant radiation hazard.

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*The U.S. Nuclear Regulatory Commission is developing a definition of "high-level waste" that would include other material of such a highly radioactive and long-lived nature that it requires placement in the permanent repository.

Although medical and industrial shipments of radioactive materials are by far the most numerous, it is shipments of low- and high-level wastes and spent fuel that cause the greatest public concern and controversy. Federal regulations governing these shipments are extensive, yet in the absence of widespread public confidence in Federal safety activities, over 650 additional State and local laws have been enacted attempting to control and even ban the movement of radioactive wastes.[2]

The public is understandably apprehensive about the movement of highly radioactive materials. Even though such operations are not new here or abroad,

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*A third category, radioactive materials for the defense industry—research, propulsion, and weapons—is not considered here, although problems related to shipments of hazardous materials by the U.S. Department of Defense are discussed briefly in ch. 5 in the enforcement training section.

[1] Harold S. Javits, et al., *Transport of Radioactive Material in the United States*, SAND84-7174 (Albuquerque, NM: Sandia National Laboratories, April 1985); and EG&G Idaho, Inc., *The 1984 State-by-State Assessment of Low-Level Wastes Shipped to Commercial Disposal Sites*, DOE/LLW-50T (Washington, DC: U.S. Department of Energy, December 1985), p. 6.

[2] N.P. Knox, et al., "Nuclear Waste Programs," *Transportation of Radioactive and Hazardous Materials: A Summary of State and Local Legislative Requirements for the Period Ending December 31, 1985*, ORNL/TM-9985 (Oak Ridge, TN: Oak Ridge National Laboratory for the U.S. Department of Energy, April 1986), p. v.

Table 3-1.—Summary of Unclassified Radioactive Materials Shipments by the Nuclear Regulatory Commission (NRC) Licensees and the Department of Energy (DOE) Licensees

Sector	Number of packages/year		Percent of total packages
	NRC licensees	DOE licensees	
Medical	1,730,000	16	61.5
Industrial	213,300	—	7.6
Nuclear fuel cycle	114,000	6,246	4.2
Waste (all sectors)	181,000	1,146	6.5
R&D and academic	17,100	1,802	0.7
Other	526,500	22,580	19.5
Total	2,781,900	31,790	100.0

SOURCE: Harold S. Javits, et al., *Transport of Radioactive Material in the United States*, SAND84-7174 (Albuquerque, NM: Sandia National Laboratories, April 1985), pp. 16 and 28.

Table 3-2.—History of Domestic Commercial Spent Fuel Shipments

Year	Method	Number of shipments[a]	Number of assemblies
1973	Truck	83	185
	Rail	6	72
1974	Truck	222	333
	Rail	1	13
1975	Truck	166	198
	Rail	4	64
1976	Truck	291	291
	Rail	18	324
1977	Truck	444	444
	Rail	27	407
1978	Truck	230	230
	Rail	24	256
1979	Truck	79	83
	Rail	15	105
1980	Truck	22	22
	Rail	5	32
1981	Truck	81	242
	Rail	2	13
1982	Truck	100	297
	Rail	—	—
1983	Truck	[b]	
	Rail		
1984	Truck	132	571
	Rail	50	883
1985	Truck	30	153
	Rail	50	883

[a] For 1976 to 1985, the number of shipments was derived from the number of fuel assemblies of either the boiling water reactor (BWR) or pressurized water reactor (PWR) type sent by each mode. It was assumed that: all rail casks held 18 BWR assemblies or 7 PWR assemblies; legal weight truck casks were used up through 1980 (with a capacity of 2 BWR or 1 PWR assemblies); and overweight truck casks were used from 1981 to 1985 (with a capacity of 7 BWR or 3 PWR assemblies).

[b] Some of the shipments credited to 1982 actually occurred in 1983. D.F. Newman, Battelle Pacific Northwest Laboratories, personal communication, April 1986.

SOURCE: Science Concepts, Inc., "Containers for Transporting Radioactive Materials," OTA contractor report, September 1985, p. 5 (1973 to 1975 data); and D.F. Newman, Battelle Pacific Northwest Laboratories, written communication, April 1986 (1976 to 1985 data).

they are complex and potentially dangerous. Concerns have been voiced that the packaging may be inadequate, packaging test criteria do not reflect realistic accident conditions, industry does not always follow safety procedures, localities cannot exercise sufficient control over routing, and the consequences of an accident could be far more severe than government and industry reports indicate.[3]

Unless substantial progress on resolution of issues is made, controversy over the transportation of high-level radioactive materials will increase as greater quantities of spent fuel must be moved from reactor sites that have exhausted their onsite storage capacities. As many as 22 reactors are expected to have no more spent fuel pool capacity available between 1987 and 1993, unless alternatives now being actively explored, such as reracking, rod consolidation, or dry cask storage, can be implemented.[4] The Nuclear Waste Policy Act of 1982 (NWPA) requires that, starting in 1998, DOE take title to spent nuclear fuel at commercial reactor sites and, when necessary, transport it to a repository. A permanent waste repository may not be available by that date,

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[3] Marvin Resnikoff, *The Next Nuclear Gamble* (New York, NY: Council on Economic Priorities, 1983); Stephen N. Salomon, *State Surveillance of Radioactive Material Transportation*, NUREG-1015 (Washington, DC: U.S. Nuclear Regulatory Commission, 1984); and Joseph Strohl and Lindsay Audin in U.S. Congress, Office of Technology Assessment, "Proceedings of OTA Workshop on Nuclear Materials Packaging Technology," unpublished typescript, Feb. 8, 1985.

[4] U.S. Department of Energy, *Spent-Fuel Storage Requirements*, DOE/RL-84-1 (Washington, DC: U.S. Government Printing Office, May 1984); and Marvin Smith, Supervisor, Nuclear Engineering, Virginia Electric Power Co., personal communication, April 1986.

Table 3-3.—Quantities of Low-Level Radioactive Waste Shipped and Buried in 1984

Disposal site	Volume (m^3)	Percent total	Radioactivity (curies)	Percent of total
Barnwell, SC	34,879	47	383,079	64
Beatty, NV	2,069	3	544	1
Richland, WA	38,481	51	215,286	36
Total quantity	75,429	100	600,909	100

SOURCE: EG&G Idaho, Inc., "The 1984 State-By-State Assessment of Low-Level Radioactive Wastes Shipped to Commercial Disposal Sites," DOE/LLW-50T, prepared for the U.S. Department of Energy, December 1985.

Table 3-4.—Radioactive Material Shipments Associated With the Nuclear Fuel Cycle (annual shipments per 1,000 megawatt reactor)

Material	From	To	Quantity[a]	Activity (Ci)	Shipments[b]
U ore	mine	mill	$3.4(10)^5$ MT	$1.4(10)^3$	6,300
Yellowcake	mill	refinery	307 MT	360	20
UF_6	refinery	enrichment	266 MTU	360	22
Enriched UF_6	enrichment	fuel preparation	43 MTU	62	6
UO_2	fuel preparation	fuel fabrication	43 MTU	62	12
New fuel assembly	fuel fabrication	reactor	43 MTU	62	7
Spent fuel assembly[c]	reactor	storage	16 MTU	$7.6(10)^6$	13
			24 MTU	$1.1(10)^7$	8[d]
Low-level waste	refinery	burial site	280 m^3		25-38
Low-level waste	fuel fabrication	burial site	180 m^3		19-25
Low-level waste	reactor	burial site	100-1,000 m^3		≈60

[a] MT is metric tons, MTU is metric tons of uranium.

[b] All shipments are by overweight truck using current generation of casks except where noted.

[c] 1,000 MWe reactors of different design may discharge different amounts of spent fuel annually. This table is based on an international study. U.S. reactors, however, discharge 28 to 32 MTU per year.

[d] Rail shipments using current generation of rail casks.

SOURCE: Essam El-Hinnawi, "Environmental Impacts of Production and Use of Energy," *Transport of Radioactive Materials* (New York: United Nations Environment Program, 1981).

and DOE has proposed moving much of the stored spent fuel to a monitored retrievable storage facility. In the meantime, shipments of spent fuel will continue in connection with intra-utility transfer and storage plans and DOE research and development.

For these reasons, Congress asked OTA to study the issues surrounding shipments of radioactive materials, especially spent nuclear fuel and high-level wastes. The focus of this first part of chapter 3 is specifically on the containers used for spent fuel, their integrity, and the procedures surrounding their use in transportation. The technical issues related to the containers will be evaluated as will the institutional, legal, jurisdictional, and public policy issues surrounding spent fuel shipments. These latter are as important and as difficult to assess as the technical issues. In particular, this section will address these questions:

- Are current technical standards and safety analysis methods for spent nuclear fuel containers adequate?
- How safe is the transport of spent reactor fuel, and what may be the consequences of an accident?
- What improvements are necessary in the safety procedures for container manufacture, transportation, and container and vehicle inspections?
- What public concerns must be addressed as the country prepares for increased spent fuel shipments under NWPA?
- What can be done to resolve legal and jurisdictional concerns regarding the choice of safe shipping routes and other operational restrictions?
- Is the public understanding of technical issues adequate to provide a basis for resolution of contentious issues? If not, what should or can be done to improve this?

Box 3B.—Reactor Operation and Spent Fuel Production

The light-water reactor (LWR) is the principal reactor type in commercial use in the United States.* Fuel for nuclear reactors consists of fuel rods in the form of 12- to 13-foot long, zircalloy tubes about ½ inch in diameter, filled with ceramic uranium oxide pellets. These rods are bundled together to form fuel assemblies. In the LWR, the fuel assemblies are immersed collectively in a coolant (water), where they form the reactor core. The control rods interspersed among the fuel rods control the rate of fission in the reactor fuel. Heat from fission and, to a much lesser extent, from the decay of fission products is used to heat water to steam, which is used to generate electricity.

After about 3 years, the buildup of fission products in a fuel assembly impedes the efficiency of the chain reaction. When the concentration of U^{235} in the fuel is around 1 percent, the assembly, considered spent fuel, is removed and replaced with fresh fuel. LWRs discharge between 60 and 175 assemblies, or a total of about 28 to 32 metric tons of uranium** of spent fuel, each year.

Because of the decay of the fission products and transuranic elements, spent fuel is highly radioactive when it is initially discharged from the reactor. For this reason spent fuel units are stored in water basins to provide the cooling and radiation shielding that they require. After 6 to 12 months in the storage pools, the radioactivity decays enough to allow shipment.***

The heat output and radioactivity of spent fuel decay rapidly in the first year after discharge. The approximately 10 kilowatt (kW) of heat emitted per tonne after 1 year equates to that of one-hundred 100-watt light bulbs. The radioactivity decays less rapidly after the first year; the 10 kW at the end of the first year is reduced to about 1 kW by the end of 10 years after discharge.

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*Seventy-three of the 74 U.S. commercial powerplants are light-water reactors (LWRs). The one high-temperature gas-cooled reactor at Fort St. Vrain, CO, operates like an LWR but uses helium gas for its coolant.

**Note that only the mass of the initial uranium is considered in the measurement of fuel amounts and not the mass of the rest of the assembly. A metric ton, or tonne, is equivalent to 1,000 kilograms, or about 2,205 pounds. The estimate of 60 assemblies per year is for a pressurized water reactor and the estimate of 175 assemblies per year is for a boiling water reactor.

***Many spent fuel casks are licensed to transport fuel that has been cooled for 150 days. Although commercial utilities typically ship only fuel at least several years old, shipments of 150-day-old fuel by the U.S. Department of Energy and the U.S. Department of Defense are not unusual.

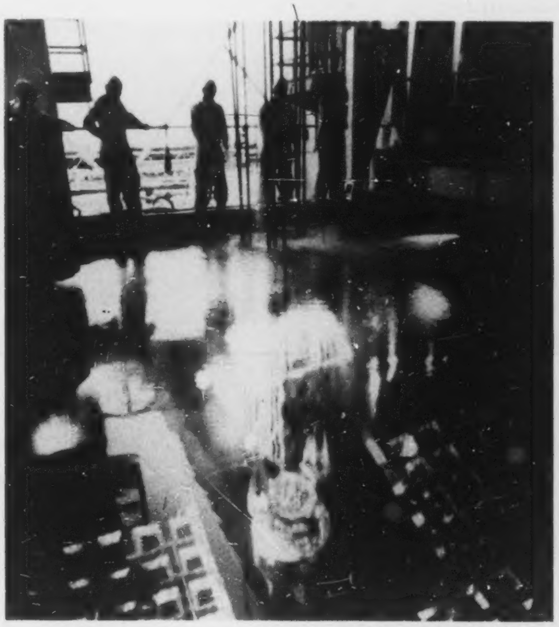

Photo credit: U.S. Department of Energy

Spent fuel storage basin at a commercial nuclear powerplant.

The information in this chapter is derived from technical literature, interviews with technical experts and concerned citizens, and from an OTA workshop on nuclear materials packaging.[5]

Regulatory Framework

While the primary Federal regulatory responsibility for shipments of radioactive materials lies with DOT, NRC and DOE also have specific responsibilities. Under its authority, DOT has issued regulations covering all aspects of transporting radioactive materials, including requirements for the containers, the mechanical condition of the transportation vehicles, and the training of personnel, as well as the routing requirements, package labels, vehicle placards, and shipping papers associated with shipments of radioactive materials. DOT also conducts carrier equipment inspections.

Under a Memorandum of Understanding, NRC and DOT cooperate closely to regulate containers for radioactive materials. NRC, under its own legislative authority, is responsible for regulating, reviewing, and certifying the packaging and certain transportation operations for shipments of fissile and highly radioactive materials that must be packaged very securely in Type B containers (described below) when such shipments involve NRC licensees.[6]

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[5] U.S. Congress, op. cit.

DOE also has authority, granted by DOT regulations,[7] to approve the packaging and certain operational aspects of its research, defense, and contractor-related transportation of fissile and highly radioactive materials. Although DOE is required to use standards and procedures equivalent to those of NRC in the container certification process, when DOE has chosen to exercise its own authority to use casks and procedures other than NRC-approved, substantial conflict between DOE and States and concerned citizens has arisen. Officials from New York and New Jersey were outraged to learn in July 1985 that DOE had planned to use a cask that had been refused NRC certification for nuclear waste shipments from Brookhaven National Laboratories on Long Island. Tennessee officials were similarly infuriated when they were told by DOE that a spent fuel shipment to be used for research would be moving through the State sometime in the next few months. Tennessee insisted on and received more specific information from DOE and assurances that the State procedures and requirements would be met.[8]

DOE has established the Office of Civilian Radioactive Waste Management to plan and establish specific regulatory and procedural guidelines for spent fuel shipments under NWPA. A more complete discussion of issues related to NWPA shipments may be found on page 106. DOD has authority similar to DOE's to use equipment and procedures equivalent to NRC's.

DOT sets regulations for all other packaging for radioactive materials in consultation with NRC. NRC approval is required of routes for shipments needing physical protection during transport to prevent theft or sabotage, but the routes chosen must be compatible with DOT regulations described in chapter 4.

Guidelines for public radiation protection are established by the U.S. Environmental Protection Agency and follow international criteria established by the International Commission on Radiological Protection and the National Commission on Radiation Protection. DOT and NRC regulations are based on these guidelines, which establish upper limits on radiation levels around containers.

U.S. regulations for containers used for radioactive materials transportation are based on internationally accepted performance standards. International regulations and standards divide the materials to be shipped into three categories based on their radioactivity levels:*

1. low hazard or very low levels of radioactivity requiring "strong tight" containers,"
2. somewhat higher levels of radioactivity requiring secure containers called "Type A" packages, and
3. fissile materials and those with very high levels of radioactivity requiring exceptionally durable containers called "Type B" packages.

Federal regulations limiting the radioactive contents for the commonly used strong tight and Type A containers are based on the assumption that the containers might break open in an accident and release some of the contents. In contrast, Type B packages, frequently called casks, are required to be sufficiently strong to withstand severe accident conditions, thus providing for safety largely independent of procedural and other controls on the shipment. To assure that Type B packages are designed, constructed, handled, and loaded in a fashion that protects public health and safety, NRC must approve and certify container designs and make certain that quality assurance procedures are implemented for manufacturing, operating, and maintaining the casks.

While the philosophy is to use Type B containers as the first and most important device for public protection, there are additional regulations and requirements for their transportation to reduce potential radiological hazards. First, the movement of high-level radioactive materials involves a much greater degree of scrutiny by NRC and DOT than do shipments of low-level materials. NRC monitors the quality assurance programs of its licensees for the construction and operation of spent fuel shipping casks and requires operational checks, such as leak tests, for the casks prior to each use. NRC also conducts routine checks for compliance with regulations at its licensees' facilities. To increase the number of inspections without overtaxing the agency, NRC has transferred authority for inspection of certain activities, including shipment of byproduct, source, and less than critical quantities of special nuclear materials to "Agreement" States.[9]

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[6] 10 CFR 71.4; also, "Transportation of Radioactive Materials: Memorandum of Understanding," *Federal Register*, vol. 44, No. 128, July 2, 1979. Among the 22,000 Nuclear Regulatory Commission and Agreement State licensees are manufacturers and users of radiopharmaceuticals, oil exploration companies, 127 nuclear powerplants, and 90 nonpower reactors and their supply industries.

[7] 49 CFR 173.7.

[8] Personal communications from DOE and State officials and congressional staff, August to October 1985.

*International Atomic Energy Agency Safety Series 6, 1985, now contains a fourth category called "surface contaminated object," which is under consideration to become a U.S. category.

However, authority for activities related to commercial spent fuel shipments remains with NRC, and its inspectors are on hand at licensees' facilities to monitor the beginning of any spent fuel shipping campaign. In the period July 1983 to June 1985, NRC conducted more than 300 inspections of spent fuel shipments at origins and destinations.[10] As an added precaution, some States through which spent fuel shipments pass may require inspection of shipments by State personnel as well.

NRC also requires that the Governors of affected States be notified in advance of commercial shipments of spent fuel and certain other highly radioactive materials. The information provided must include the name, address, and telephone number of the shipping organization, as well as a description of the material and estimates of times of arrival at State boundaries. DOE notification procedures are much less explicit, creating friction with many States. Moreover, certain shipments that involve national security are exempt from this requirement, although DOT requires postnotification of many shipments of highly radioactive materials.

Both DOT and NRC have the authority to impose fines for violations of regulations. However, the enforcement efforts of both agencies have been the subject of severe criticism. NRC has had "too much of a closeness with industry . . ." according to NRC Commissioner, James K. Asselstine.[11] The adequacy of DOT's relatively small inspection forces has been questioned for monitoring the millions of shipments of radioactive materials that do not involve spent fuel.[12] For further details on inspection levels see chapter 5.

Containers

Packaging regulations and standards for shipping radioactive materials were first established in 1946 by the Interstate Commerce Commission, based on recommendations by the National Academy of Sciences. The standards were subsequently adopted by the International Atomic Energy Agency (IAEA) and 53 nations. As part of an ongoing international evaluation of the standards, there have been several updates, including provision in 1967 for Type A and Type B packaging standards. The United States recently revised its regulations slightly to make them consistent with 1973 IAEA guidelines.[13]

The need for technical improvements to the packages is examined as an ongoing part of research and development, and Type B packages have been a focus of DOE-funded research over the years. An international meeting of experts in this area, Packaging and Transportation of Radioactive Materials, is held periodically, about every 3 years, providing a forum for the exchange of information.

Procedures to ensure safe packaging for transporting radioactive materials include:

- categorizing the materials according to their levels of radioactivity and form, and
- requiring the preparation and use of packaging appropriate for the type and quantity of material.

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[9] E.L. Emerson and J.D. McClure, *Radioactive Material (RAM) Accident/Incident Data Analysis Program*, SAND 82-2156 (Albuquerque, NM: Sandia National Laboratories, March 1985), p. 7. As of 1986, 28 States are Agreement States and responsible for regulating their 13,000 licensees. NRC is still responsible for regulating its 9,000 material licensees and its some 200 reactor (power and nonpower) licensees, even if they are physically located in an Agreement State. Stephen Salomon, Office of State Programs, U.S. Nuclear Regulatory Commission, personal communication, February 1986.

[10] Alfred W. Grella, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, "NRC Inspection Activities on Recent Shipments of Spent Fuel 1983 to Present," unpublished manuscript of speech presented at the Spent Nuclear Fuel Transportation Seminar, Chicago, IL, Aug. 1, 1985.

[11] Howard Kurtz, "NRC Officials Avoid Pursuit of Wrongdoing, Critics Say," *Washington Post*, Apr. 8, 1986, p. A-1.

[12] Paul Rothberg, Science Policy Research Division, Congressional Research Service, "Hazardous Materials Transportation: Laws, Regulations, and Policy," Issue Brief IB76026, Mar. 11, 1986, p. 5.

[13] 10 CFR 71, *Federal Register*, Aug. 5, 1983; International Atomic Energy Agency standards adopted in 1985 require a 200 meter submergence test to allow for transport over coastal ocean depths. Because no U.S. shipments now travel by sea, the United States has not yet considered adoption of this new requirement.

The choice of packages is based on the form and quantity* of the material shipped. There are two forms: normal-form and special-form. Most materials are classified as normal-form. They are not highly radioactive, and although they constitute about 87 percent of all radioactive packages shipped annually, they include only 10 percent of the curies. Special-form materials are generally encapsulated solids that present a hazard due to direct external radiation if they escape from the package; although they constitute only about 13 percent of all radioactive packages, they include 90 percent of all the curies shipped annually.[14] However, special-form solid material is not readily dispersible and has high physical integrity, and thus poses relatively little risk from inhalation or ingestion. The quantity of radioactivity in the material is indicated by four subdivisions: excepted or limited quantity, low specific activity, Type A, and Type B.

Excepted material is that which is so low in radioactivity that the hazards are negligible, and the materials can be shipped without special packages, shipping papers, or labels. Examples of such materials include smoke detectors, static elimination brushes, lantern mantles, luminous watch dials, and luminous exit signs. Excepted materials are regulated by DOT.

Low specific activity (LSA) material is that in which the specific radioactivity is sufficiently low that the radiological hazard presented by inhalation or ingestion of the material is very small. LSA materials include such things as uranium mill tailings, uranium ore, natural uranium hexafluoride, some low-level wastes, and most laboratory and medical wastes. LSA materials must be contained in strong and tight packages which permit no leakage of radioactive material under normal transportation conditions. Wooden boxes, 55 gallon drums, and special tank trailers fit this criteria. Containers for LSA materials are regulated by DOT in consultation with NRC. Some LSA materials, such as spent resins from reactors, are required to be packaged in NRC-certified Type A packages.

Type A packaging is intended to prevent the loss or dispersal of its contents when subjected to a specified set of "normal" transportation conditions. The conditions are actually more severe than the "normal" label implies, as is shown in box 3C. Most radiopharmaceuticals for medical uses are packaged in Type A containers, as are radioassay materials used in research and medicine, and some wastes associated with reactor operation. Type A containers are regulated by DOT in consultation with NRC.

Type B packaging requirements are the most stringent. Type B containers are employed for the larger

Box 3C.—Type A Tests: Normal Conditions of Transport* (general description)

Heat.—Direct sunlight at an ambient temperature of 100° F in still air.

Cold.—An ambient temperature of −40° F in still air and shade.

Pressure.—Reduced external pressure of 3.5 pounds per square inch (psi) absolute and increased external pressure of 20.0 psi absolute.

Vibration.—Vibration normally incident to transportation.

Water spray.—Sufficiently heavy to simulate rainfall of 2 inches per hour for 1 hour.

Free drop.—Onto a flat unyielding horizontal surface, striking in a position expected to do the most damage, through the distance specified (note: defined by table from 1 to 4 feet based on package weight).

Corner drop.—Onto each corner in succession (or each quarter of a cylindrical rim) from a height of 1 foot onto a flat unyielding surface (for all fissile Class II packagings . . . and packagings weighing less than 110 lbs).

Penetration.—Impact of the hemispherical end of a vertical steel cylinder 1¼ inches in diameter and weighing 13 lbs, dropped from a height of 40 inches and striking perpendicular to the surface at a point on the package which is expected to be the most vulnerable to puncture.

Compression.—For 24 hours, a load of either five times the weight of the package, or 2 psi times the maximum horizontal cross section of the package, whichever is greater, will be applied against the top and bottom of the packaging in the position in which the package would normally be transported. (For packages less than 10,000 lbs only.)

*From 10 CFR 71.71.

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*Quantity refers here to the degree of radioactivity.

[14] Javits, op. cit., p. ii.

Photo credit: Research and Special Programs Administration, DOT

Marking for radioactive materials, required by Federal regulations.

quantities and high-level radioactive materials. Type B packages are required for most fissile materials, spent fuel, highly radioactive waste, irradiated components, radioactive sources for medical therapy, industrial radiography sources, highly contaminated equipment, and power sources for pacemakers. Type B "overpacks" are frequently used for shipping many Type A packages when additional protection is required. NRC regulations contain the standards for Type B containers and certifies the designs used in their construction. The Type B test sequence—drop, puncture, and exposure to heat and water immersion—is described on page 100. DOT regulations allow the use of either DOE- or NRC-certified Type B and fissile packages in commerce.

Type B Containers for Spent Fuel

Underlying the Type B packaging standards is the assumption that the possibility of an accident can never be eliminated and that the package must be able to survive severe accident conditions without a dangerous release of its contents. Thus, NRC regulations provide a set of performance criteria for the containers, rather than specific design requirements. The intent is to remove the need to predict specific accident events and circumstances and to provide a set of engineering test specifications for impact, puncture, temperature, immersion, and leak tightness that encompass the types of conditions that could occur in an accident.

The basic criteria for Type B cask design are virtually the same in every nation with a commercial nuclear program. The most widely recognized Type B containers are the casks for transporting highly radioactive spent reactor fuel from commercial nuclear powerplants. The casks are 10 to over 20 feet long and are constructed of two concentric, welded, stainless steel shells typically 1 to 2 inches thick each, enclosing a gamma radiation shield of lead or depleted uranium metal and a water or other hydrogenous material neutron radiation shield. These casks were designed to contain and ship for reprocessing spent fuel that had been removed from the reactor 4 to 5 months previously and that was still relatively radioactive. However, since no reprocessing of commercial fuel is being carried out in the United States, no utilities are currently shipping fuel less than 10 years old.* A general description of the current generation of U.S. casks is as follows:[15]

- Truck casks (legal weight):
  - —weigh less than 25 tons,
  - —contain one to two fuel assemblies, and
  - —can be unloaded in less than 12 hours.
- Truck casks (overweight):
  - —weigh up to 40 tons and are restricted in movement,
  - —contain three to seven fuel assemblies, and
  - —can be unloaded in less than 16 hours.
- Rail casks:
  - —weigh up to 100 tons,
  - —contain between 7 and 24 fuel assemblies, and
  - —can be unloaded in 28 to 36 hours.

Specific descriptions of spent fuel casks in use in the United States today may be found in table 3-5.**

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*The U.S. Department of Energy and the U.S. Department of Defense routinely make such shipments, however, for research purposes and nuclear submarine maintenance.

[15] U.S. Department of Energy, *Spent Fuel Storage Fact Book*, DOE/NE-0005 (Washington, DC: April 1980), p. 54.

**Monolithic, all-steel casks and nodular cast iron casks are already used in Europe and Japan. Prototypes of such casks have been submitted to the Nuclear Regulatory Commission (NRC) for testing, but none has yet been certified. In the case of nodular cast iron casks, a highly ductile cast iron is required to prevent brittle fractures, which have been a problem in casks tested to date, according to NRC.

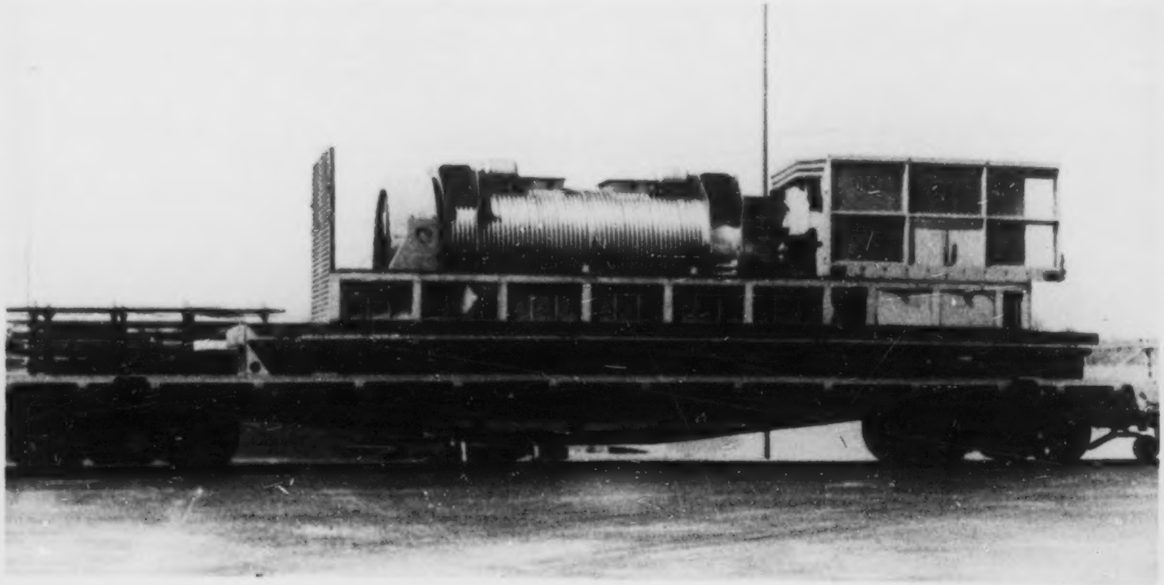

Photo credit: General Electric

Rail cask mounted and secured on a railcar.

Table 3-5.—Characteristics of the Current Generation of Nuclear Regulatory Commission Certified Light Water Reactor Spent Fuel Casks

	Nuclear Assurance Corp. Norcross, GA			General Electric Morris, IL	Transnuclear, Inc. White Plains, NY	
Cask name	NAC-1/NFS-4[a]	NLI-½	NLI-10/24	IF-300	TN8	TN9
Transport mode[b]	LWT	LWT	Rail	OWT/Rail	OWT	OWT
PWR/BWR assemblies/cask[c]	1/2	1/2	10/24	7/18	3/0	0/7
Loaded weight (tons)	22.5	24	95	63.5 to 70	38	38
Gamma shield	lead	lead/U	lead/U	uranium	lead	lead
Neutron shield	borated water	water-glycol	water-glycol	water-glycol	resin	resin
Cavity coolant	inert gas	helium	helium	inert gas	inert gas	inert gas
Exterior surface	smooth	smooth	stainless steel fins	corrugated	copper spines	copper spines
Units operating	5[d]	5	2[e]	4[f]	4[g]	2[h]

[a] Not currently licensed to transport spent fuel from power reactors.
[b] LWT—legal weight truck; OWT—overweight truck.
[c] PWR—pressurized water reactor; BWR—boiling water reactor.
[d] One unit owned by Duke Power (for transporting spent fuel onsite only).
[e] Cask has never been in service.
[f] One unit owned by Carolina Power & Light.
[g] Two certified units operating in Europe.
[h] One unit owned by Commonwealth Edison.

SOURCE: Sandia National Laboratories, *Commercial Experience Involving the Transportation of Spent Fuel and High Level Waste in the United States*, TTC/009 (Albuquerque, NM: May 1981).

Accident Conditions and Test Standards

The hazards associated with highly radioactive materials require the use of special, exceptionally durable packages for transportation. Establishing standards for the design and construction of such packages requires that the types and severity of conditions that could be experienced in an accident be understood and defined.

The Federal approach to ensuring container safety includes:

- **Performance standards** that are specified by NRC and converted by the cask designer to specific design requirements for the container.
- **Engineering test conditions** that are established to encompass real accident conditions. The test conditions may be satisfied by computer analyses, model testing, full-scale tests, or a combination of all three methods.

Performance standards specify how a container must perform under specified conditions, tests, and environments. The infinite number of possible accident variables precludes development of a standard worst-case accident. Consequently, a set of engineering test conditions, based on evaluations of actual accidents, have been chosen to encompass and generally exceed the types of actual accident conditions. Having specific test criteria makes it possible to duplicate tests and compare consequences with different designs and at different times and achieve consistent results. This approach to engineering safety is the basis for current engineering practices, whether for bridges, skyscrapers, or aircraft.

To evaluate whether a cask design conforms to the regulations, NRC requires detailed structural, thermal, and nuclear safety analyses, computer modeling, and scale-model or full-scale tests. The evolution of both computers and modeling techniques has led to reliable ways to establish the adequacy of container designs without destructive testing,[16] and many studies have examined the validity of computer modeling and scale-model tests of casks in accident environments. Where parameters are not known with sufficient precision, assumptions are used that will overestimate damage to a cask.

Full-scale tests have shown that the mathematical analyses, computer models, and scale-model tests accurately predict the behavior of full-scale casks.[17] In a series of tests, a spent-fuel cask was dropped onto several kinds of surfaces at an impact speed of 45 mph.[18] For this velocity, analyses based on the regulatory requirement of impact with an "unyielding" surface predicted a deceleration (or measurement of the amount of energy absorbed by the cask and causing damage) of 1,200 gs. (A "g" is a unit of force equivalent to the force due to gravity.) The full-scale test produced 1,000 gs. For impact onto concrete, the analysis predicted 900 gs; the actual test produced 600 gs. While the models do not precisely predict the actual conditions, the difference is always conservative, predicting higher than actual impact energies. Further studies are being conducted to improve the accuracy of the computer models and to establish extremely severe accident condition bounds.[19] Similar results and confidence exist in the computer models for evaluating scale-model tests.[20]

The engineering tests established to encompass accident conditions for Type B packages can be summarized as follows.[21] The conditions are to be applied sequentially to determine the cumulative effect on a package:

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[16] M. Huerta, *Analytical and Scale Modeling Techniques for Predicting the Response of Spent-Nuclear Fuel Shipping Systems in High-Velocity Impacts Against a Rigid Barrier*, SAND77-0270 (Albuquerque, NM: Sandia National Laboratories, April 1978); see also, M. Huerta and H.R. Yoshimura, *A Study and Full-Scale Test of a High-Velocity Grade-Crossing Simulated Accident of a Locomotive and a Nuclear-Spent-Fuel Shipping Cask*, SAND79-2291 (Albuquerque, NM: Sandia National Laboratories, February 1983).

[17] J.D. McClure, et al., "Relative Response of Type B Packaging to Regulatory and Other Impact Test Environments," *Proceedings of the 6th International Symposium on Packaging and Transportation of Radioactive Materials (PATRAM)*, vol. II, held in Berlin, Federal Republic of Germany (Springfield, VA: National Technical Information Service, November 1980), pp. 1247-1252.

[18] W.E. Wowak, *Research and Development at the Transportation Technology Center*, SAND TTC-0484 (Albuquerque, NM: Sandia National Laboratories, 1984); presented at the Packaging and Transportation of Radioactive Materials Seminar, Washington, DC, April 1984.

[19] A.A. Trujillo, et al., "Thermal and Structural Code Evaluation," *Proceedings of the 7th International Symposium on Packaging and Transportation of Radioactive Materials (PATRAM)*, held in New Orleans, LA (Springfield, VA: National Technical Information Service, May 1983). The Nuclear Regulatory Commission is currently sponsoring research at the Lawrence Livermore Laboratories into the engineering conditions that have resulted from very severe transportation accidents.

[20] W.E. Baker, "Scaling and Prediction of Impact Puncture of Shipping Casks for Radioactive Materials," *The Shock and Vibration Bulletin*, Bulletin 48 (Washington, DC: Naval Research Laboratory, September 1978); see also, B. Evason, "Impact Modeling and Reduced-Scale Tests," *The Urban Transport of Irradiated Fuel* (London: Macmillan Press, 1984), p. 233.

[21] 10 CFR 71.73.

- **Free drop**.—A free drop of 9 meters onto a flat, essentially unyielding, horizontal surface, striking the surface in a position for which maximum damage is expected.
- **Puncture**.—A free drop of 1 meter, striking in a fashion for which maximum damage is expected, the top end of a vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface. The bar is 15 centimeters in diameter, with the top horizontal and its edge rounded to a radius of not more than 6 millimeters, and such a length as to cause maximum damage to the package, but not less than 20 centimeters long. The long axis of the bar is perpendicular to the unyielding, horizontal surface.
- **Thermal test**.—Exposure to a thermal test in which the heat input to the package is not less than that which would result from exposure of the whole package to a radiation environment of 800° C for 30 minutes, with an emissivity coefficient of 0.9. The package may not be cooled artificially.
- **Water immersion** (for fissile material packages only).—Immersion in water to the extent that all portions of the package are under at least 15 meters of water for a period of not less than 8 hours.

Familiarity with the engineering principles involved is critical to understanding the safety provided by the casks. These four conditions have been widely described, in simplified form, in popular literature on the subject of the transportation of spent fuel.[22] However, simplified descriptions often cannot accurately represent the technical criteria, and at least two of these are often misunderstood—the free drop and thermal test conditions.

The free drop, or drop test criterion of 9 meters, about 30 feet, may appear substantially inadequate considering that the maximum reported falling distance for a rail accident was 76 feet and for a truck accident, 89 feet.[23] In addition, concern has been voiced over the chance of an accident in which a cask falls from a bridge 300 feet above water.[24] The critical engineering condition in the criterion is the use of an *unyielding* surface, meaning that all of the energy resulting from impact is absorbed by the cask. Such a surface provides a worst-case and consistent basis for testing and engineering design purposes. Sandia National Laboratories have conducted tests and analyses of casks on conventional common surfaces to compare damages inflicted on casks after impact with an *unyielding* surface.

However, virtually no natural surface or manmade structure encountered in the transportation environment would be *unyielding*. Almost all surfaces will yield, thus absorbing some of the impact energy that would otherwise go into damaging the cask. The 30-foot drop test results in a cask velocity of 30 mph on impact. To produce the same damage as a 30-mph collision with an unyielding surface, a cask velocity of 65 to 90 mph is required. Sandia also dropped a smaller Type B test container 2,000 feet onto hard, undisturbed earth.[25] The cask hit the ground at 235 mph and buried itself some 4½ feet into the ground. The cask suffered no damage other than paint abrasion, although dropping a similar cask 30 feet onto an unyielding surface at an impact velocity of 30 mph produced visible damage. See box 3D for a description of the Sandia National Laboratories full-scale cask tests.

A British Central Electricity Generating Board demonstration in 1984, in which a locomotive crashed into a cast steel cask* at 100 mph, while dramatic, caused little damage to the cask. More to the point, the energy imparted to the cask on impact was about

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[22] International Atomic Energy Agency, *Safe Transport of Radioactive Material* (Vienna, Austria: May 1982); George Russ, *Nuclear Waste Disposal: Closing the Gap* (Bethesda, MD: Atomic Industrial Forum, June 1984), p. 21; Resnikoff, op. cit., p. 20.

[23] Ridihalgh, Eggers, & Associates, Inc., *Definition of Bounding Physical Tests Representative of Transport Accidents—Rail and Truck*," vol. 1 (Washington, DC: U.S. Nuclear Regulatory Commission, Aug. 30, 1982), p. 98.

[24] Joseph Strohl, in U.S. Congress, op. cit.

[25] I. Waddoups, *Air Drop Test of Shielding Radioactive Material Containers*, SAND75-0276 (Albuquerque, NM: Sandia National Laboratories, September 1975).

*Cast steel casks do not have the weldments that have proven to be troublesome in some current casks. Although they are widely used in Europe, no cast steel casks have yet been licensed for use in the United States.

Box 3D.—Full-Scale Spent Fuel Cask Crash Tests

In 1976 and 1977, a series of full-scale tests were undertaken for the U.S. Department of Energy by Sandia National Laboratories. Obsolete casks containing nonirradiated stainless steel clad fuel were used in the tests, since the intent was not to certify the integrity of a specific operational cask, but to compare predictions to actual events involving a cask accident.

The primary purpose of the tests was to validate the computer models used to design and evaluate spent fuel shipping casks. The tests also provided other information. These were the first full-scale accident simulations conducted on a spent fuel cask. The tests allowed full instrumentation to be utilized in order to assess the magnitude of the forces and other stresses encountered in a number of accident cases. By using these measurements it was possible to validate the use of "lumped parameter" models to predict accident environments over the entire range of possibilities. The test program also included sub-scale tests (one-eighth and one-fourth scale) to evaluate the accuracy of reduced scale testing.

The program began with the development of "lumped parameter" models which were used to predict the accident environment which the spent fuel casks would encounter. Calculations were made to determine the tiedown strengths, structural crush-up, and structural failure, all of which were translated into time v. velocity predictions for the cask. These calculations, for example, predicted that in the 60 mph truck accident the tiedowns would not fail until very late in the event resulting in the cask impacting the wall at about 30 mph. Actual impact velocity was 27 mph. Using the same analytical tools it was predicted that in the 80 mph impact, the tiedowns would fail early and the resulting impact velocity would be about 65 mph. Actual impact was 65 mph. The results of these "lumped parameter" calculations were then applied in determining the effect on the shipping cask. Calculations using the widely accepted technique known as finite element analysis predicted cask deformations in each case under study. Engineers then used these analytical predictions to estimate the extent of cask failure, if any, that would be produced by the test. Scale models were built and tested to evaluate the analytical results and the scale-model testing techniques themselves.

Cracks occurred both in the bodies of the casks and in some of the weldments, and, in one fire test, the lead radiation shield began to vaporize. Nonetheless, the actual accident damage to the cask was the same as or less severe than the predictions. The predictions were in good agreement with the results even where they overestimated damage. Any additional stresses that might have occurred had irradiated, zircalloy fuel rods (currently used throughout the nuclear fuel industry) been used or damaged in the casks were not addressed by the tests and deserve further study.

one-sixth that which would have been imparted by a 30-foot drop test onto an unyielding surface.[26]

The thermal test specifies a temperature of 800° C (1,475° F) and may appear to understate real fire conditions, since typical flame temperatures for burning fuels are 1,850° to 2,200° F. The criterion requires a "radiation environment" for the whole package of 800° C, *not* a flame temperature of 800° C, and further specifies that an emissivity coefficient of the source of at least 0.9 and an absorptivity of the cask of at least 0.8 must be assumed for calculations. Producing a thermal "radiation environment" equivalent to 800° C requires a flame temperature higher than 800°. The emissivity coefficient refers to the amount of heat that the flames are assumed to radiate (90 percent) compared to the maximum theoretical amount, 100 percent, that could be radiated by ideal flame sources. The cask absorptivity coefficient is specified as 0.8, or 80 percent of the theoretical maximum heat absorption. These technical specifications require that the cask be completely enveloped in the thermal environment so that the cask absorbs virtually all of the heat, with little of it being radiated or conducted away. A stainless steel cask may have an initial absorptivity of about 0.2 and a fire about 0.5 to 0.6. The net result is that the heat absorbed by the cask in the test environment is greater than it would be in a real fire.

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[26] Richard Cunningham, U.S. Nuclear Regulatory Commission, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Advisory Panel Meeting on Hazardous Materials Transportation," unpublished typescript, June 27, 1985, p. 250.

Sandia National Laboratories conducted an experiment in which a spent fuel cask, designed to withstand a 60-minute fire, was suspended over a pit filled with burning jet fuel. However, the fuel was cut off after 100 minutes, because due to defects in cask manufacture, heat caused the outer shell of the cask to crack and the lead shielding began to vaporize. Regulations specify a 30-minute exposure to a 1,475° F thermal environment; jet fuel burns at about 1,800° F. Nonetheless, under these conditions, instruments showed that the thermal environment was less severe than the casks are required to meet.[27] A number of technical organizations have conducted tests confirming that a 1,475° F temperature is a realistic *thermal environment* associated with fires as hot as 1,850° F.[28]

Such results are consistent with the fact that in a real fire, the temperature is not uniform and the cask is not totally enveloped. A fully engulfing fire, as regulations specify, is difficult to imagine since the cask will be resting on a vehicle or the ground, and will thus be partially protected from heat—and a means will exist for conducting some heat away. Natural and many accidental fires have varied temperature profiles with peak flame temperatures of about 1,850° F. However, some railroad fires burn at higher temperatures, and the fire in the enclosed environment of the Caldecott tunnel in Oakland, California, created a thermal environment that approached that of the regulatory standards. The Federal Railway Administration is considering testing casks to determine whether internal cask temperatures remain at safe levels under extreme fire conditions.[29]

Flame emissivities are strongly associated with flame thickness—the greater the flame thickness, the higher the effective emissivity. However, increasing flame thickness for open fires also reduces ventilation, and if a fire were to engulf a cask, it would reduce ventilation for the flames surrounding the cask, and thus tend to lower flame temperatures.[30] Finally, the very high theoretical flame temperatures for certain chemical fires can be achieved only under ideal conditions, often requiring a direct air supply to the fuel.

A third test, **the puncture test**, is generally well understood. However, new equations and analytical methods have been developed since the current cask designs were certified[31] that will increase the accuracy of future tests.

The four criteria set out are intended to result in a cask design sufficiently robust to withstand different types of accidents and do not specifically include all types of accident events. For example, there is no requirement for the cask to withstand a torch-like flame that may be created in a tank car accident; nevertheless, tests have been conducted on shipping casks to observe and measure the effect of a torch. Test results show that because the torch introduces heat to a limited area of the cask, and the large cask has a high heat capacity and is an effective thermal conductor, the torch flame produces conditions less severe than the all engulfing fire condition.[32]

A crushing force is another accident condition not directly specified by the regulatory criteria. An NRC-sponsored study of this condition concluded that casks that meet the impact and puncture criteria are at least equally resistant to crushing forces.[33] Another study concluded that the crushing load of an entire locomotive on the (spent fuel) packages that meet the requirements will not exceed the packages' capability, based on bounding crush loads of half of the 400,000 pound weight of the locomotive resting on the package.[34]

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[27] R. Pope, et al., *An Assessment of Accident Thermal Testing and Analysis Procedures for Radioactive Materials Shipping Packages*, 80-HT-38 (Washington, DC: American Society of Mechanical Engineers, April 1981).

[28] Ibid.

[29] Claire L. Orth, Office of Safety Analysis, Federal Railroad Administration, U.S. Department of Transportation, personal communication, March 1986.

[30] W. Dircks, Nuclear Regulatory Commission, Washington, DC, "Staff Memorandum, Feb. 10, 1982," unpublished typescript.

[31] Charles E. MacDonald, Certification Division, Nuclear Regulatory Commission, personal communication, May 1986.

[32] M.G. Vigil, et al., *HNPF Spent Fuel Cask Temperature Response: Torch Impinging on Water Filled Neutron Shield*, SAND82-0702 (Albuquerque, NM: Sandia National Laboratories, March 1982); Philip E. Eggers, et al., "Thermal Response of HNPF Spent Fuel Shipping Container in Torch Environments," *Proceedings of the 6th International Symposium on Packaging and Transportation of Radioactive Materials—1980* (Springfield, VA: National Technical Information Service, November 1982).

[33] U.S. Nuclear Regulatory Commission, *Potential Crush Loading of Radioactive Material Packages in Highway, Rail, and Marine Accidents*, NUREG/CR-1588 (Washington, DC: October 1980).

OTA performed independent calculations that satisfactorily verified these analytical results.[35] Box 3E provides answers to some commonly raised questions about the casks.

The NRC cask certification process is of necessity painstaking and time-consuming. The safety record of NRC-certified casks, however, provides a degree of public confidence in the casks. The regulatory system governing the movement of radioactive materials has worked well. There have been no releases of radioactivity from the accidents involving spent nuclear fuel containers currently certified for transportation. Of the 2,552 packages for low-level radioactivity materials involved in accidents between 1971 and March 1985, only 67 were sufficiently damaged to cause releases. These packages are not required to contain the material in the event of an accident, and all releases involved low levels of activity that posed little threat to public health. (See table 3-6.)

Risk—Accident Probabilities and Consequences

An assessment of overall public risk must combine estimates of probability and consequence. Moreover, estimates of accident probabilities must include two factors: 1) the probability that any given vehicle carrying spent fuel will be in an accident, and 2) the probability that the spent fuel shipping cask will release any of its contents. The first of these is relatively easy to assess since a large amount of actuarial data about accident rates have been developed. Bureau of Motor Carrier Safety statistics show that accidents involving trucks occur once every 400,000 miles of travel, while rail statistics from the Federal Railroad Administration show that a rail accident occurs every 139,000 miles of travel. This translates into a probability of 2.5×10^{-6} truck accidents and $7.2\ ^{\times 6}$ rail accidents per vehicle-mile.[36]

For the second factor, likelihood of release, estimates must be used, since there is no significant actuarial record. A report from the Transportation Technology Center at Sandia National Laboratories estimates that fewer than 1 in 100 accidents would involve conditions severe enough to cause concern over a release of some contents of the cask.[37] This estimate appears consistent with analyses of the stresses involved in numerous actual highway and rail accidents of all types. The analyses show that real accident stresses do not exceed the test conditions in the regulatory standards in 99.5 and 99.9 percent of truck accidents involving impact and fire, respectively; as well as 99.6 and 99.9 percent of rail accidents involving impact and fire, respectively.[38] Thus, the overall probability of a truck or rail shipment of spent fuel being involved in an accident where conditions are sufficiently severe to cause some release of radioactive materials is less than 2.5×10^{-8} per vehicle-mile—or less than once for every 40 million miles of transport.

Table 3-7 shows estimates based on an OTA analysis of truck and rail accident rates in the year 2000. Current DOE estimates indicate that there are likely to be about 1,000 annual shipments from commercial reactors to a storage site.[39]

The consequences of a spent fuel cask accident involving radioactive material releases are proportional to the quantities of radioactivity released, the estimated health effects of the specific radioactive materials released, and the exposure of individuals or population groups to the materials. Related variables include:

- **The age of the spent fuel.**—Older spent fuel—out of the reactor for 5 or more years—is much cooler than recently discharged fuel both in thermal and radiological terms. If more spent fuel is carried in each cask to reduce the number of necessary trips, the amount of thermal activity in the cask will increase. The radioactivity available for release and the heat available to raise the temperature of the spent fuel

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[34] Philip E. Eggers, *Severe Rail and Truck Accidents: Toward a Definition of Bounding Environments for Transportation Packages*, NUREG/CR3499 (Washington, DC: Nuclear Regulatory Commission, October 1983), p. 69.

[35] OTA background analysis, June 1985.

[36] Edward W. Sheperd, *Transportation Technology Center Quick Reference File*, Item TTC/012, SAND79-2101 (Albuquerque, NM: Sandia National Laboratories, May 1981).

[37] Ibid.

[38] T. Wolff, *The Transportation of Nuclear Materials*, SAND84-0062 (Albuquerque, NM: Sandia National Laboratories, December 1984).

[39] U.S. Department of Energy, "Environmental Assessment for a Monitored Retrievable Storage Facility," *Monitored Retrievable Storage Submission to Congress*, vol. 2, RW0035, review copy, unpublished typescript, December 1985, p. 2.23.

Box 3E.—Brief Answers to Common Questions

A wide range of public concerns has been raised regarding the transportation of spent reactor fuel. Many of the concerns surround three general areas:

1. What happens if a spent fuel cask is in an accident that causes it to leak?
2. Can the fire test standards really be adequate if they specify a temperature lower than that at which many substances burn?
3. What is the worst that can happen?

Facts pertinent to the questions:

1. What happens if a spent fuel cask is in an accident that causes it to leak?
   - The shipping casks are 10 to over 20 feet long, weigh 20 to 100 tons and are constructed of two concentric stainless steel shells, typically 1 to 2 inches thick enclosing a radiation shield of lead. A broken cask would be one in which, for example, the lid (itself weighing several tons) or a valve on the cask were to leak.
   - Spent fuel is a solid ceramic-like material. It has a melting point higher than any fire temperature and cannot explode.
   - In the event of an accident with a large fire, the heat might cause release of small amounts of volatile radioactive elements in the spent fuel. These would disperse rapidly, and health effects would be minimal.
   - The principal radiation risk is from the possibility of inhaling any radioactive materials released in the accident. Only people at the immediate scene are likely to be affected.
   - The amounts of radiation exposure likely to be associated with such an accident are lower than those associated with radiation exposure from many natural sources.[1]
   - State and local emergency response personnel must be trained properly to deal with the accident by sealing off the accident area and notifying appropriate response experts. Federal technical assistance is available from both the Nuclear Regulatory Commission and the U.S. Department of Energy.*
2. Can the fire test standards really be adequate if they specify a temperature lower than that at which many substances burn?
   - Yes, spent fuel shipping casks are required to meet certain overall thermal requirements, which include but are not limited to, fire temperatures.
3. What is the worst that can happen?
   - No one can be certain what the worst might be, since there has never been an accident with any significant release. A series of events, including poor quality control during cask manufacture or improper preparation for shipping, would have to transpire before any release at all would occur. Another series of events would have to take place related to the accident before the release would be more than negligible. However, fatalities due to the nonradiological consequences of an accident are far more likely than any due to radiation. Environmental and property damage and long-term health impacts are more difficult to assess.
   - The worst event is often considered sabotage. Sandia National Laboratories have conducted experiments with explosives to measure the quantity of radioactive material that could be released—they discovered that 0.0006 percent could be released, an amount too small to be significant.[2]

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*See chapter 5 for additional information on emergency response training.

[1] See for example R.R. Fullwood, "Risks Associated With Nuclear Material Recovery and Waste Preparation," *Nuclear Safety*, vol. 25, September-October 1984, p. 665; and U.S. Congress, Office of Technology Assessment, *Managing the Nation's Commercial High-Level Radioactive Waste*, OTA-O-171 (Washington, DC: U.S. Government Printing Office, March 1985), p. 46, which shows 3,000 to 4,000 latent cancer fatalities per year due to natural background radiation.

[2] R.M. Jefferson, *Shipping Cask Sabotage Source Term Investigation*, NUREG/CR-2472 (Washington, DC: Nuclear Regulatory Commission, 1982).

must thus be carefully analyzed. High temperatures are necessary for volatile materials to be released.

- **The types of material released.**—Radioactive material released from a damaged spent fuel assembly will not necessarily escape from the shipping cask. Small amounts of radioactive gases, mainly the inert gas Krypton 85, could escape readily from the assembly, but will dissipate relatively harmlessly in the open air. Other more critical radioactive materials, such as volatile cesium and rubidium isotopes, will tend to plate

Table 3-6.—Radioactive Materials Involved in Transportation Accidents (January 1971 to March 1985)

Packaging category contents	Number of packages involved	Number of packages failing	Number of packages releasing contents
Strong tight industrial and miscellaneous unclassified	596	62	56
Type A	1,956	28	11
Type B:			
Spent fuel (see box B)	4	0	0
Medical sources	24	0	0
Uranium hexafluoride	3	0	0
Radiography and well logging	8	0	0
Other Type B	11	0	0
Total Type B	50	0	0

SOURCE: J.D. McClure and A. Tyron-Hopko, *Radioactive Material Transportation Accident Analysis*, SAND85-1016 (Albuquerque, NM: Sandia National Laboratories, July 1985).

Table 3-7.—Estimated Occurrences of Accidents During the Transport of Spent Fuel

Mode	MTUs[a] per shipment	Miles per shipment	Total number of shipments per year	Accidents[b] per year	Years between accidents[c] where stresses approach performance test
With MRS[d]:					
Trucks to MRS	1.0	700	725	1.27	158
Rail to MRS	7.0	700	250	1.26	159
Rail, MRS to repository[e]	112.5	2,400	22	0.38	526
Without MRS:					
Truck	1.0	2,400	725	4.35	46
Rail	7.0	2,400	250	4.32	46

[a] MTU—metric ton of uranium.
[b] Assumes one accident per 400,000 miles for truck (BMCS data) and one accident every 139,000 train miles for rail (FRA data).
[c] Assumes that 99.5 percent of highway and rail accidents are less severe than the performance tests (Robert M. Jefferson, Sandia Report SAND84-2128, TTC-0528, January 1985).
[d] MRS—monitored retrievable storage.
[e] Assumes MRS is in Tennessee. Assumes the repository is in Nevada.

NOTE: Shipments will begin in the year an MRS is opened.

SOURCE: Office of Technology Assessment.

out on the surfaces of the cask, making them less likely to reach the environment.[40]

- **The location (in a rural or urban area) of an accident.**

Estimates have been made of the combined risks to the public based on the probability of an accident and using the consequences of the releases. Sandia National Laboratories estimates that the probability of an accident involving spent fuel causing five or more fatalities over time is low—5×10^{-6} a year. No more than five early fatalities were considered possible under worst-case accident conditions in a heavily populated urban area.[41] Another estimate puts the risk in slightly different terms: 1×10^{-8} latent cancers per 1,000 MW(e)* powerplant for six trips transporting spent fuel 1,000 miles.

However, the environmental and/or economic effects of a transportation-related release require thorough examination.[42] Not considered heretofore has been the extent of public injury or loss of life that might be caused by nonradiological risk, such as the magnitude of the accident, fire, and damage associated with an accident severe enough to damage a spent fuel cask. The nonradiological risk of death associated with moving the spent fuel is estimated to be 1 million times greater than the radiological risks.[43]

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[40] W. Dircks, *Fission Product Release From Highly Irradiated Fuel*, NUREG/CR-0722 (Oak Ridge, TN: Oak Ridge National Laboratory, 1980). A series of experiments on irradiated fuel found a fractional release of 0.3 percent for cesium from the fuel elements—not from the cask. Such a release was estimated to produce no early fatalities.

[41] U.S. Nuclear Regulatory Commission, *Transportation of Radionuclides in Urban Environs: Draft Environmental Assessment*, NUREG/CR-0743 (Washington, DC: July 1980), p. 66.

*Megawatts of electricity.

[42] Western Interstate Energy Board, "Environmental Assessment for a Monitored Retrievable Storage Facility," *Nuclear Waste Policy Act: Monitored Retrievable Storage Submission to Congress*, vol. 2, DOE/RW-003, unpublished review manuscript, December 1985, p. 5-4.1.

Sabotage has also been used as a condition for assessing the possible consequences of a spent fuel accident. Data show that historically, sabotage and vandalism have not been problems associated with the transportation of hazardous materials (see chapter 2, part II for detailed information). However, the increase in international terrorist activities indicates that the possibility of a successful sabotage effort is not to be discounted. Early analyses for NRC indicated an estimated five to nine early fatalities and up to 1,800 latent cancer fatalities associated with radioactive material releases following a successful act of sabotage on a spent fuel cask in an urban area.[44] Based on a conservative assumption that about 0.7 percent of the contents of a spent fuel cask could be released in respirable form following a successful sabotage attack, NRC developed transportation safeguard rules requiring an armed guard to accompany each spent fuel shipment. In 1981 and 1982 simulation tests were conducted to evaluate the release consequences of an explosive attack on spent fuel casks.[45] The simulations showed a release of 0.0006 percent of the cask contents,[46] reducing estimates to no early fatalities and, at most, 14 latent cancer fatalities in an urban population that would normally experience 250,000 cancers over the same period.[47] On the basis of these revised estimates, NRC proposed relaxing the safeguard rules. Their proposal met with objections from a number of States, and a final decision on safeguard requirements is still pending.[48]

Future Spent Fuel Shipments Under the Nuclear Waste Policy Act

The passage of the NWPA of 1982 established that DOE will take title to spent fuel from utilities in 1998 and assume responsibility for its transportation and ultimate disposal. As there will be some 90,000 spent fuel assemblies in U.S. spent fuel pools by that time,[49] DOE may be responsible immediately for a number of shipments to a repository or monitored retrievable storage facility. Depending on the type and carrying capacity of the casks ultimately constructed and certified for these shipments, DOE estimates that approximately 250 rail and 725 truck shipments will be required annually to move spent fuel from eastern reactors to a monitored retrievable storage facility or repository.[50] For NWPA shipments, DOE has agreed to meet DOT and NRC safety and security requirements in effect at the time and will use only transportation casks that have received an NRC certificate of compliance.[51]

A new generation of casks is being designed and tested and will be employed to move spent fuel to a national repository under NWPA. Sometime in 1986 the Office of Civilian Radioactive Waste Management at DOE will issue a "Request for Proposal" for the design and construction of these casks. The new casks are likely to have somewhat different characteristics from those of the current casks, which carry between 1 and 24 assemblies (see table 3-5), because they will be designed to hold older, less radioactive spent fuel. Since the oldest fuel will be shipped first, most of the initial shipments will be of fuel at least 20 years old,[52] and it is likely that the next generation of casks will carry significantly greater numbers of assemblies. The designs will be based on carrying the maximum possible number of spent fuel elements within weight and safety limits, to reduce the number of shipments necessary. Recent improvements in materials, such as ductile, nodular cast iron, and design, such as monolithic steel, have yielded casks that may meet many concerns voiced about today's casks.

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[43] R.R. Fullwood, "Risks Associated With Nuclear Material Recovery and Waste Preparation," *Nuclear Safety*, vol. 25, No. 5, September-October 1984, pp. 654-667.

[44] U.S. Nuclear Regulatory Commission, *Transportation of Radionuclides in Urban Environs*, op. cit.

[45] R.P. Sandoval, et al., *An Assessment of the Safety of Spent Fuel Transportation in Urban Environs*, SAND82-2365 • TTC-0398 (Albuquerque, NM: Sandia National Laboratories, June 1983).

[46] Robert M. Jefferson, *Shipping Cask Sabotage Source Term Investigation*, NUREG/CR-2472 (Washington, DC: U.S. Nuclear Regulatory Commission, 1982).

[47] Sandoval, et al., op. cit.

[48] Terry Lash, Director, Illinois Department of Nuclear Safety, at U.S. Nuclear Regulatory Commission/U.S. Department of Transportation, Spent Nuclear Fuel Transportation Seminar, Chicago, IL, Aug. 1, 1985.

[49] George Russ, Atomic Industrial Forum, Bethesda, MD, personal communication, 1985. See also U.S. Congress, Office of Technology Assessment, *Managing the Nation's Commercial High-Level Radioactive Waste*, OTA-O-171 (Washington, DC: U.S. Government Printing Office, March 1985), p. 28.

[50] U.S. Department of Energy, "Environmental Assessment for a Monitored Retrievable Storage Facility," op. cit., p. 2.23.

[51] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Office of Storage and Transportation Systems, "Transportation Institutional Plan," unpublished internal review draft manuscript, Mar. 3, 1986, pp. 3 and D-57.

DOE is also examining the possibility of employing very large capacity dual-use casks for transportation. These dry casks, currently under review by NRC for utility-site storage purposes only, offer an opportunity to minimize the number of shipments and the handling of the spent fuel. Once the fuel has been removed from the reactor and placed in dry, onsite storage in these dual-use casks, the handling and worker-exposure risk would be reduced if the same casks could be used to transport the spent fuel to a repository. However, the conditions for casks used for transportation are more stringent, and although NRC has pending applications for certification of two such casks, none has yet been certified for both purposes.[53]

Moreover, questions will need to be answered about the effects of the large, heavy casks on the stability of the carrying vehicles, whether truck or railcar. The weight would not be a concern if barge transportation were used, and water transportation has the best modal safety record. However, the increased handling necessary to transfer the cask from truck or rail to barge and the increased turnaround time required for reusable casks by the slower barge travel are trade-offs that must be considered. Finally, the integrity of the casks for transport after possible weakening from corrosion and thermal effects, subsequent to extended onsite storage of a decade or more, must be studied.

Spent Fuel Transportation Risks and Public Perceptions

About 6,500 spent fuel assemblies have been shipped to date in the United States. While several accidents have occurred involving spent fuel casks in the United States (in one case the cask was empty), there has never been a shipping accident involving a Type B package carrying spent fuel that caused a significant release of radioactive material. (See box 3F for a brief description of four typical incidents involving Type B casks.)

DOT maintains a Hazardous Material Information System (HMIS) which, with additional data

Box 3F.—Spent Fuel Casks Involved in Transportation Accidents[1]

December 8, 1971.—A tractor-trailer rig carrying a spent fuel cask with one fuel element left the highway to avoid a head-on collision. The truck rolled over and threw off the cask. The driver died of injuries. The cask sustained minor damage and did not release any contents.

February 9, 1978.—Shortly after leaving its point of origin, a trailer, carrying a cask containing six fuel elements, buckled from the weight. The cask stayed on the trailer and was not damaged. There was no leakage.

August 3, 1978.—An empty cask being loaded on a trailer broke through the trailer bed causing minor damage to the impact limiter and the cask base plate. No radioactive material was released.

December 9, 1983.—The trailer carrying a spent fuel cask, containing seven spent fuel assemblies, uncoupled from the tractor, leaving the cask sitting on the trailer supported by its rear wheels and a "jo-dog"* in front. When the air and electrical lines parted, the brakes on the trailer and "jo-dog" locked, bringing the unit to a rapid stop on the highway. The uncoupling occurred as the tractor began moving after a momentary stop in a construction zone. There was no damage to the cask and no release of radiation.

[1] R. Jefferson, former Manager, Transportation Technology Center, Sandia National Laboratories, Albuquerque, NM, personal communication, 1985.

*A "jo-dog" is an apparatus that connects the front end of a trailer to a tractor. It has its own set of wheels. It was used in this case to distribute the weight more evenly over the axles.

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[52] Lake Barrett, Director, Transportation and Waste Systems Division, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, personal communication, Dec. 5, 1985.

[53] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, *Annual Report to Congress*, DOE/RW-0004/2 (Washington, DC: March 1986), p. 23.

from NRC files and other sources, supports the Radioactive Materials Transportation Accident/Incident Data Base developed by the Transportation Technology Center at Sandia National Laboratories under DOE contract. HMIS records since 1971 indicate that about 0.6 percent of all entries involved radioactive materials; of these, about 20 percent were transportation accidents.[54] Table 3-6 lists the numbers and categories of all radioactive materials involved in reported transportation accidents occurring between January 1971 and March 1985.

This safety record not withstanding, public attention focuses sharply on any accident involving nuclear materials, and Federal officials must respond frequently[55] to questions about the adequacy of Federal safety requirements.[56] The effect of this debate has been a heightened public awareness of the risks associated with transporting radioactive materials, especially spent reactor fuel. One result of this awareness has been the enactment of numerous State and local laws restricting operations and routing of radioactive materials, especially spent fuel and high-level waste shipments. Such restrictions have frequently led to local and national legal disputes. For further discussion of these disputes, see chapter 4.

At the root of much of the discussion, debate, and concern over spent fuel shipments are three factors:

1. The extent to which risk and benefit issues are difficult to explain. In the case of spent fuel shipments, there is no actuarial record of public fatalities, so risk estimates must be based on calculations.
2. The extent to which the public is apprehensive about nuclear energy and radiation in general or distrusts the nuclear industry because of previous accidents and transfers this to the movement of spent fuel on routes in their State or city.
3. The extent to which the public is aware of the demonstrations and technical information now available and the extent to which it is possible to explain the relevant technical information in a popular forum.

These factors all involve problems that are common to technology and risks, and nuclear energy in general, and are not specific to the transportation of spent reactor fuel. Nonetheless, a brief examination of some of the disparities between perceived and statistically determined risks may be useful.

A large and growing body of literature is devoted to the issues of risk, public perception, risk management, and education. Nuclear energy is often used as a specific case.[57] The fact that public and expert opinion diverge dramatically, for example, on the issue of nuclear safety is a case in point—in one poll, out of 30 activities involving risk, experts ranked nuclear power number 20 while the public ranked it number 1—the most hazardous.[58] The explanations for this phenomenon are not simple and are themselves a subject of debate.

The difference between the statistical risks and perceptions of risk are substantial. For example, the actuarial record for the shipment of other energy commodities provides evidence for much greater risk and a consistent record of public fatalities. There are estimated to be some 29 annual public fatalities associated with highway shipments of gasoline, 14 associated with highway shipments of propane, and 9 associated with rail shipments of chlorine.[59] The record for public fatalities from spent fuel shipments to date is zero, and is estimated to be 0.0001 fatalities due to radiological factors per year with 2,000 shipments per year;[60] 15 to 100 fatalities are estimated for spent fuel shipments over the lifetime of a repository. Some of the radiological fatalities associated with a spent fuel accident are latent cancers calculated to occur over the life of the exposed individuals, as opposed to the prompt deaths associated with the other accidents.[61]

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[54] OTA calculations based on Sandia National Laboratories, *A Review of Accident/Incident Experience Involving the Transportation of Radioactive Material*, SAND81-1330C-Summary (Albuquerque, NM: March 1982). Reported categories include handling accidents and "actual or suspected release of radiation or materials" and "surface contamination" in excess of regulatory requirements.

[55] R. Jefferson, *Transporting Spent Reactor Fuel: Allegations and Responses*, SAND82-2778 (Albuquerque, NM: Sandia National Laboratories, March 1983); R. Jefferson, et al., *Analysis of Recent Council on Economic Priorities Newsletter*, SAND82-1250 (Albuquerque, NM: Sandia National Laboratories, March 1983); Dircks, *Fission Product Release From Highly Irradiated Fuel*, op. cit.

[56] Sierra Club, "Shipping Casks: Are They Safe?" *Sierra Club Radioactive Waste Campaign Fact Sheet* (Washington, DC: no date); and Resnikoff, op. cit.

[57] See for example, Alvin Weinberg, "Science at Its Limits," *Issues in Science and Technology*, vol. II, No. 1, fall 1985, pp. 59-72; Peter Huber, "The Bhopalization of U.S. Tort Law," *Issues in Science and Technology*, vol. II, No. 1, fall 1985, pp. 73-82; and Baruch Fischoff, "Managing Risk Perception," *Issues in Science and Technology*, vol. II, No. 1, fall 1985, p. 83.

[58] William F. Allman, "Staying Alive in the 20th Century," *Science 85*, vol. 6, 1985, pp. 31-41.

[59] Andrew P. Hull and Edward T. Lessard, *Risk Comparisons for the Nuclear Transportation of Spent Fuel From Nuclear Reactors*, BNL #36390 (Long Island, NY: Brookhaven National Laboratory, no date). These estimates exclude fatalities due to collision forces.

[60] Ibid.

Yet such disparities are common in the area of public perceptions of risks, and the pitfalls associated with the conventional means for addressing these perceptions have been widely discussed.[62] Although OTA suggests many of these same methods in the conclusions for this chapter, their effectiveness has limitations. To paraphrase one expert's observations:

- *Those presenting factual information* must recognize the role that personal values play in assessing information.
- *Those giving statements of regulatory philosophy* must remember that people can understand risk-benefit trade-offs.
- *Experts explaining* technical material must communicate in an appropriate manner.
- *Communities considering problems* need to keep in mind that their decisions will affect many other jurisdictions.

Conclusions

OTA finds that technical evidence and cask performance in service indicate that NRC performance standards yield spent fuel shipping cask design specifications that provide an extremely high level of public protection, much greater than that afforded in any other current hazardous materials shipping activity. However, meticulous adherence to the designs during cask manufacture and to required safety procedures during loading and transport are critical factors in ensuring public and environmental safety. Transportation accidents involving shipments of spent fuel will inevitably occur. However, OTA concludes that the probability of an accident severe enough to cause extensive damage to public health and the environment caused by a radiological release from a properly constructed cask is extremely remote. Moreover, the health and environmental consequences in the event of a severe accident are likely to be lower than those resulting from many hazardous materials transportation accidents considered more routine.

The most difficult issue pertaining to the transportation of spent fuel is how best to reduce the risks. Areas for technical improvement to the casks often involve trade-offs that adversely affect overall transportation safety. For example, increasing the thickness of the cask walls to increase accident resistance slightly would necessitate reducing the carrying capacity of the cask to remain within weight limits. More shipments would be necessary to carry the same amount of spent fuel, increasing the probability of accidents. Moreover, an increased number of shipments would require more handling by workers, raising their total radiation exposure.[63]

OTA further finds that continued research is needed in certain technical areas to determine where safety improvements could be effective. Such research needs include: the interface between the carrying vehicle and the casks, such as tiedowns and fasteners; the evaluation of real accident stresses as compared to those specified by the current regulations; and methods of extending accident modeling capabilities to encompass accidents more severe than those currently incorporated in the models. In addition, continued study of safe routes and different transportation modes and configurations and sharing the results of these studies with affected jurisdictions would have useful results. To enhance the risk assessment capability of jurisdictions, DOE could revise for microcomputers its existing mainframe computer program for analyzing the risks to population of differing transportation routes. This is discussed more fully in chapter 2.

The level of public apprehension about shipments of spent fuel requires well planned and coordinated programs to address the concerns. Sensitivity to public concerns and programmatic coordination have heretofore not been outstanding at DOE, which will be responsible for NWPA shipments. The technical specifications for the shipping casks are difficult to explain and comprehend, creating widespread misunderstanding of the stringency of the standards for ensuring spent fuel cask integrity. Industry and government will do well to address these apprehensions in a forthright manner.

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[61] See for example Hull and Lessard, op. cit.; Sheperd, op. cit.; and Jefferson, op. cit.

[62] Fischhoff, op. cit.

[63] Robert Jefferson, former Manager, Transportation Technology Center, Sandia National Laboratories, Albuquerque, NM, personal communication, 1985.

OTA further finds that fruitful areas for improvements in the overall safety of spent fuel transportation are to be found in the institutional, procedural, and operational controls and arrangements, such as quality assurance and quality control measures in cask manufacture; maintenance activities; operator, handler, and driver training; and inspection.[64] NRC inspection and quality assurance requirements are intended to ensure that each user establishes and implements a comprehensive cask inspection and operational testing program. The duration of the inspection depends on the inspectors' confidence in the quality assurance programs, training procedures, and the shippers' ability to demonstrate that procedures are being followed.[65] It is appropriate to consider actions that will ensure that the quality control standards are followed. Furthermore, tight management supervision during all transportation operations and strict accountability for adhering to procedures are crucial to ensuring safety. DOE could minimize one area of current public concern by agreeing immediately to use NRC-approved casks for all its shipments.

The nontechnical aspects of spent fuel transportation safety need continued and forceful emphasis. Special attention to shipping operations, including quality control and inspection can have a positive impact on overall safety. Especially important are those related to the carrying vehicle, and training and information programs for drivers, engineers, and other transportation personnel.

OTA finds that sustained and comprehensive public information efforts are necessary to address concerns about the level of safety provided by Federal regulations and cask specifications. Citizens and public officials repeatedly say, "show me"[66] that the casks are safe, and experts often respond with technical evidence that, due to its extreme complexity, may not be comprehensible. Education programs for nonexpert audiences must be developed, and continued examination of the issues by nonpartisan, nonexpert individuals is important. For example, in its publication, "A Nuclear Waste Primer," the League of Women Voters, although expressing some concerns, concluded that "compared to the transport of other hazardous materials, radioactive shipments have an excellent record."[67]

The broadest possible public participation and information sharing will be important for successful undertaking of NWPA shipments. The enactment of State and local regulations pertaining to this transportation reflects the desire of jurisdictions to determine for themselves the conditions under which they will accept the risks associated with spent fuel transport. Figures 3-1, 3-2, and 3-3 indicate the routes used and the most frequent origin and destination States for highly radioactive shipments. These and other States, as well as Indian tribes and local governments affected by shipments have an interest in an acceptable level of safety. States and tribal and local governing bodies have indicated that they will require negotiations with DOE to permit successful completion of NWPA shipments. The activities undertaken by utilities to accomplish spent fuel shipments are documented in box 3G. Because DOE will fill the role of the utilities for shipments made under NWPA, Congress may want to consider requiring DOE to undertake the same activities under NRC regulations.

Furthermore, OTA concludes that State, local, and Indian tribal officials must be included in the transportation planning and decisionmaking process for transportation under NWPA. A Federal approach that incorporates public perceptions, opinions, and responsibilities starting immediately could be helpful. In November 1985, DOE sponsored a workshop for State, tribal, and local officials to determine the extent and specific nature of their concerns about DOE's plans for shipments of spent nuclear fuel under NWPA. Such activities provide a

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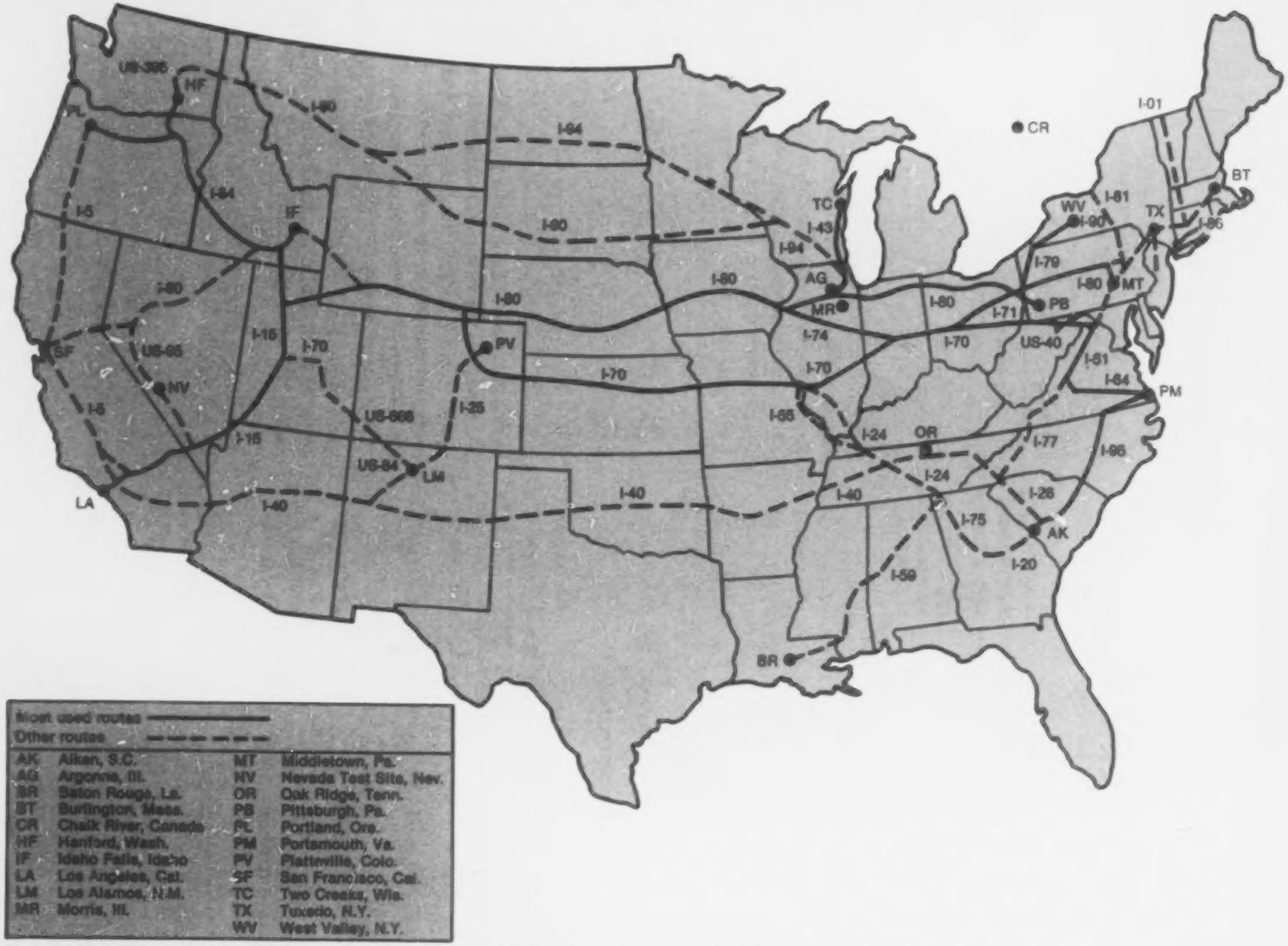
[64] This aspect was a persistent theme in both the Office of Technology Assessment workshop and Advisory Panel meetings; see for example Richard Cunningham, Nuclear Regulatory Commission in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Transportation of Hazardous Materials Advisory Panel Meeting," op. cit., p. 230.

[65] Charles E. MacDonald in U.S. Congress, Office of Technology Assessment, "Proceedings of OTA Workshop on Nuclear Materials Packaging Technology," op. cit., p. 142.

[66] U.S. Congress, Office of Technology Assessment, "Proceedings of OTA Workshop on Nuclear Materials Packaging Technology," op. cit.

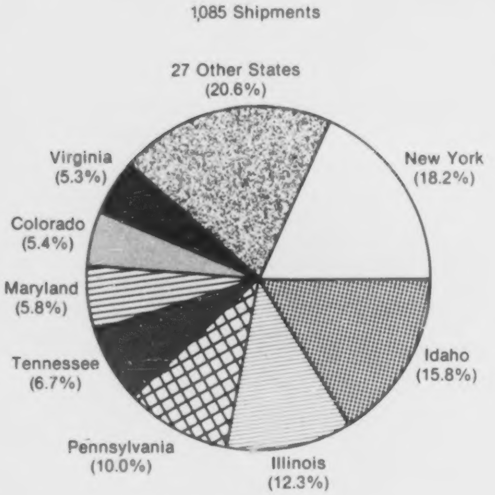
[67] League of Women Voters Education Fund, *The Nuclear Waste Primer* (New York: 1985), p. 42.

Figure 3-1.—Highways Commonly Used for Radioactive Materials Shipments



SOURCE: Sandia National Laboratories, *An Assessment of the U.S. Department of Transportation's Radioactive Materials Routing Report*, January 1986.

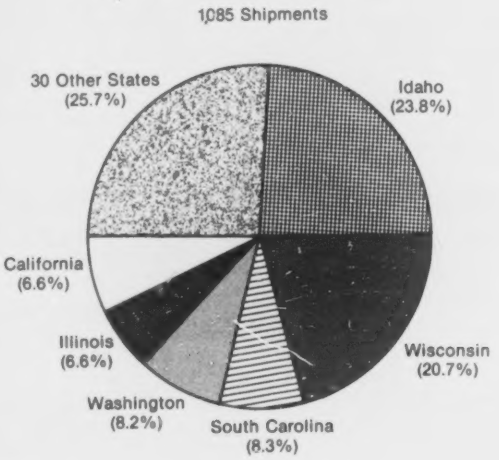
Figure 3-2.—Point of Origin, 1982-84



Most frequent points of origin for spent fuel, large quantity, and highway route controlled quantity shipments.

SOURCE: Sandia National Laboratories, *An Assessment of the U.S. Department of Transportation's Radioactive Materials Routing Report*, January 1986.

Figure 3-3.—Destination, 1982-84



Most frequent destinations for shipments of radioactive materials.

SOURCE: Sandia National Laboratories, *An Assessment of the U.S. Department of Transportation's Radioactive Materials Routing Report*, January 1986.

forum for airing differences and moving toward resolution of conflicts. **OTA concludes that additional meetings, sponsored jointly by DOT, NRC, and DOE, in cooperation with public interest groups such as the National Governor's Conference, the National Conference of State Legislatures, and the International Conference of Mayors are essential to informing the public and improving intergovernmental coordination.**

States and localities are greatly concerned with routing for spent fuel shipments, since they have the authority under DOT routing regulations to designate alternative shipping routes. State authorities can work with Indian tribes, local jurisdictions, and neighboring States to develop an alternative route meeting DOT guidelines. DOE and DOT may find it necessary to work together and with the States to provide guidance and support in achieving consensus on routes. (Chapter 4 gives further information on routing.)

Finally, full-scale tests of cask durability, like those conducted by Sandia National Laboratories in 1976 to 1977 (see box 3D) and Britain's Central Electricity Generating Board test in 1984 can demonstrate that accident damage and the behavior of the casks have been adequately predicted and validate the engineering models and analytical methods.[68]

OTA concludes that once a new generation of casks has been developed and fulfilled the analytical test requirements for NRC certification, full-scale demonstration tests could play an important role in gaining public confidence. The following considerations are important:

- Will a demonstration be for the purpose of increasing public confidence or does the technical evidence show the need for benchmark full-scale tests to prove the validity of current engineering analyses and regulations?
- If technical or material changes in the cask designs require a full-scale technical validation experiment, how can questions about any subsequent changes to cask designs be addressed?
- If a "show me" test were conducted, assurances that it would address public concerns would be essential. Organizations and individuals critical of current transportation procedures and cask standards could be included in advance planning for a test, so that their views are incorporated from an early point.

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[68] Huerta and Yoshimura, op. cit.; see also International Atomic Energy Agency Safety Series 6, 1985; and David Fishlock, "Nuclear Fuel Shipping Cask Comes Through Great Train Wreck With Its Virtue Intact," *Energy Daily*, vol. 12, No. 142, July 24, 1984, p. 3.

Box 3G.—Anatomy of a Spent Fuel Shipment

Utilities have found that transporting spent nuclear reactor fuel from one storage site to another is a lengthy process, requiring careful planning and preparation. The transporter must deal with numerous complicated and seemingly conflicting Federal and State regulations as well as pressure not to expose the public to the perceived danger of such shipments. OTA asked several companies that have shipped fuel successfully to document their shipping procedures as well as the attendant legal difficulties and public discussions.

After reactor fuel has been irradiated so that it is no longer a useful part of the power-producing process, it is removed from the fuel core and termed spent fuel. Initially, spent fuel is highly radioactive, exceeding lethal radiation levels, and is consequently carefully contained. Upon removal from the reactor, the spent fuel rods are placed in water-filled containment pools. The water shields the rods while their radiation content decays to safer levels. After 6 to 12 months in the containment pool, the spent fuel is ready for either onsite storage or shipment to other storage facilities.

Spent nuclear fuel is shipped for two main reasons: 1) space in a reactor storage facility is near full capacity, or 2) lawsuit settlements between a State and a utility necessitate the removal of spent fuel to an alternate storage site. It is generally cheaper to ship spent fuel to remote storage sites than to enlarge existing onsite facilities or build new ones. Of the various transport modes, truck and rail are the most common. The truck mode is used most often because—legal and public relations difficulties notwithstanding—it provides quick, flexible, and relatively inexpensive transport.

OTA asked three companies that have undertaken three different types of shipments—transshipments; multi-State, utility-operated shipments; and second party shipments—to provide information on their spent fuel transportation experiences. Transshipments, such as those carried out by Duke Power, occur between various sites operated by the same utility. Consequently, utilities carrying out these shipments deal primarily with people in their own service areas. Shipments to a remote storage site, in contrast, usually span several States and are carried out by the utility responsible for the spent fuel. An example of this type of shipment was Wisconsin Electric's transfer of spent fuel from West Valley, New York, and Morris, Illinois, to its Point Beach Nuclear Plant in 1983 and 1984. Finally, second-party shipments are those shipments conducted by a company, such as General Electric, that is paid by a utility to transport the spent fuel. The following discussion draws in part on reports from these three companies.

As soon as it is determined that spent fuel shipments are to take place, the transporter must begin processes both to comply with regulations and to alleviate public safety concerns of communities affected by the shipments, particularly in the case of second-party shipments. The first step is usually route selection, and regulations require that the shipper submit a proposed shipping route for Nuclear Regulatory Commission approval. After final route determination, the utility often assembles mailing lists of public officials and media contacts in areas through which the shipment is to pass. Informational material is prepared that typically touches on the following topics: the nature of spent fuel, why it must be shipped, measures being taken to prevent radioactive release during transport, and the excellent safety record of spent fuel shipments to date. In addition, the company usually prepares a news release, plans informational briefings for the press and public officials, and arranges to monitor public reaction. Informational briefings may include films to dramatize the integrity of spent fuel casks. All of these activities are completed prior to public announcement of the shipments.

Once these preparations are made, the company makes a public announcement that spent fuel shipments are to take place. Utility representatives brief local media, mail information to public officials and other media, send out briefing invitations to public officials, and—as required by Federal regulations—notify the Governor or his designee in each State through which the shipment is to pass. The transporter seeks to learn as much as possible about road conditions, media, public attitudes, and State and local authorities in all areas along the route. When appropriate, company representatives meet with local officials, participate in public meetings, and give demonstrations of the safety techniques used to safeguard spent fuel. These measures may help prevent the passage of local ordinances prohibiting or severely restricting the transport of radioactive materials. Compounding the shipper's difficulties is the legal obligation not to release shipping schedules until 10 days after the shipments have occurred; such secrecy lends itself to public perception that the shipments are not as risk-free as the power company maintains. The more effective the effort to alleviate public concern, the less complicated the local constraints on transport are and the more straightforward the shipment procedures.

The shipper must also accommodate the various State regulations covering nuclear spent fuel transportation. Each State has its own authorities responsible for formulating and enforcing rules. Upon notification of upcoming shipments, the responsible agencies from each State make preparations and notify the transporter of any regulations it will have to observe. Typically, the relevant agencies are the State departments—or their equivalents—of transportation, nuclear safety, health, and the highway patrol as well as the State Police.

State regulations can require any of the following: thorough truck and cargo inspections at State borders, armed escorts (expenses to be paid by the utility), avoiding large urban areas during daylight and evening hours, compensation for emergency personnel training, and continual in-transit progress reports to be relayed to local officials along the route. Meeting these requirements on a State-by-State basis places a substantial responsibility on the shipper. Nuclear power utilities contacted by OTA noted that there seems to be little or no coordination between States regarding rules and enforcement procedures or between States and the U.S. Department of Energy. To avoid conflict and successfully conclude shipments, utilities sign separate agreements to abide by individual State and local regulations. In the case of particularly onerous requirements, utilities sometimes choose to request Federal preemption of the regulation. Federal preemption is not used often, however, as it is time-consuming and damaging to public relations.

Once agreement is reached between the utility and the States, the shipments can proceed. The total time spent in planning, preparation, and negotiation prior to transport can amount to 2 years or more. The issues outlined above are typical of the potential legal and local conflicts that nuclear utilities must deal with when transporting spent nuclear fuel. The accompanying table summarizes the problems encountered and tactics used for each type of shipment.

Summary of Spent Fuel Shipping Experiences

Company	Problems encountered	Tactics used
Duke Power Co.	Public opposition Routing decision difficulties	Public information Negotiation with NRC
Wisconsin Electric	State requirements regarding inspections, routing, and shipping escorts	Negotiations, compliance with State requirements
	Complications arising from inconsistent Federal and State regulations	Same, and subsequent legal action
General Electric	Opposition from citizens groups along the shipping route State legislation	Intense public information activities Legal action

- An extensive public information program would be essential prior to the test to help the public officials, affected emergency personnel, and the general public understand the technical background for the tests to the extent feasible.

If full-scale validation testing proves unnecessary from an engineering standpoint, conducting a full-scale demonstration test could enhance public understanding and confidence. DOE, as the responsible agency under NWPA, has both a source of funds and a program in which test series could be housed, and is giving consideration to such tests.

However, given the technical complexities involved, it is wise to be realistic about the extent to which a full-scale cask accident demonstration will allay all public concerns. Although a well-planned and constructed full-scale demonstration could prove persuasive to many, it would need to accommodate a wide range of interests. **OTA finds that the appropriate test goals could best be determined by a panel of advisors—experts and concerned citizens to provide guidance to the technical organization conducting the demonstration.**

PART II: BULK CONTAINERS AND SMALL PACKAGING FOR HAZARDOUS MATERIALS TRANSPORTATION

Most of the estimated 180 million annual shipments of hazardous materials reach their destinations safely, both because hazardous materials transportation is heavily regulated and because industry is concerned that its products reach customers intact. The strength and integrity of packagings used to ship hazardous materials, including tank trucks, railroad tank cars, and barges, as well as bottles, boxes, and drums, are an important factor in transportation safety. The Research and Special Programs Administration (RSPA) of the Department of Transportation is responsible for issuing packaging and hazard communication regulations for all hazardous materials containers except bulk marine containers, which are regulated by the U.S. Coast Guard, and containers for highly radioactive materials (see part I of this chapter).

This part of chapter 3 discusses DOT's requirements for all packagings, then looks at the specific issues relating to bulk containers and small packagings. It focuses on issues regarding the packaging regulations codified in Parts 173, 178, and 179 of Title 49 and portions of Title 46 of the Code of Federal Regulations. Part 173 contains general requirements for shipments and packagings and lists the authorized packages that can be used for each commodity. Parts 178 and 179 contain the specific, highly detailed requirements for the authorized packages referred to in Part 173. Title 46 contains the Coast Guard regulations for the water mode. (Chapter 4 presents an overview of the entire regulatory system, including a discussion of the historical development of packaging regulations.) Sources of information included technical literature, an OTA workshop on packaging, and extensive interviews with container experts.

General Packaging Criteria

DOT requires packaging for shipping hazardous materials to be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation:

- there will be no significant release of the hazardous materials to the environment;
- the effectiveness of the packaging will not be substantially reduced; and
- there will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging.[69]

In addition, packaging materials and contents must ensure there will be no significant chemical reaction among any of the materials in the package. Closures must prevent leakage, and gaskets must be used that will not be significantly deteriorated by the contents. Polyethylene packaging must be minimally permeable to and compatible with the cargo.

DOT regulations apply to hazardous materials containers of all sizes. Some regulations apply equally to all packaging, but most of the requirements depend on whether the material is shipped in bulk or in small packages. As a general matter, the dividing line between nonbulk (small) and bulk (large) containers is 110 gallons or 1,000 pounds. Small packages of hazardous materials are carried by all modes: water, rail, highway, and air. Approved packagings include drums, cylinders, boxes, cans, and bags. Bulk packages—ships and barges, railroad tank cars, tank trucks (called cargo tanks in the regulations) and intermodal portable tanks—generally do not travel by air. Analysis of incident and accident data (see chapter 2) reveals that hazardous materials packaging generally has been adequately designed, although there are some problem areas.

The premise underlying packaging design for hazardous materials other than highly radioactive materials is that the packages must maintain their integrity in the normal transportation environment, including minor accidents.

The classification of a hazardous material has a critical influence on the selection of packaging. Many commonly transported materials are listed in the regulations, and shippers need only locate the listing to be guided to the required packaging. If the material is not listed, however, the shipper must determine if it is hazardous and classify it according to definitions in the regulations. There are no specific regulations in 49 CFR that tell a shipper how to classify a material, a difficult process, the results of which affect packaging, marking, labeling, and placarding.[70]

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[69] 49 CFR 173.24.

The sorting of hazardous materials into hazard classes by either DOT or the shipper does not necessarily mean that all the potential dangers posed by these substances have been taken into account. For example, methyl isocyanate, which caused the death of thousands in Bhopal, India, had until recently been classified by DOT as a flammable substance and could legally be transported in the least stout highway cargo tanks or rail tank cars. DOT is now in the process of adopting an international classification scheme (described in more detail in a later section of this chapter) that should better correlate the strength of regulated packaging to the hazards posed by the materials. In the meantime, large manufacturing and shipping companies have incorporated additional strength and protective features into the design of containers they use for materials with a very high hazard potential. Some of these designs have become part of the Federal specifications for packages. More often, however, these additional safety features represent industry efforts to take into account special transportation circumstances.

Containers for bulk transport, discussed next, represent the inherent possibility of larger consequences in the case of an accident than do small packages and provide opportunities for commensurately larger impacts on safety.

Bulk Packaging

More than 60 percent of accidents and spills in any mode of transport are a result of human error;[71] thus modal safety is closely tied to the opportunities for error. The highway mode experiences more accidents, spills, injuries, deaths, and property damage than does the rail or water mode, in both absolute numbers and accidents per ton-mile traveled,* while the rail mode experiences more than the water mode.

Several other factors also affect safety: the extent of coverage and enforcement of Federal regulations; the amount and quality of training the vessel or vehicle operators and loaders receive; the frequency of maintenance and inspection of the vessel or vehicle; and finally, the coordination between the agencies responsible for regulation, inspection, and enforcement activities. Table 3-8 presents a comparison of modal characteristics for bulk shipping of hazardous materials. Descriptions of the containers and specific safety factors will be treated separately for each mode.

Bulk Highway Transport

Of the three modes of bulk transport of hazardous materials, the highway mode is the most versatile and widely used. (See chapter 2.) While portable tanks and tank trucks are the smallest bulk containers and thus the consequences of a release on the highway will be lower than for the other modes, the probability of an accident is greatest for the highway mode because it has:

- more miles of network,
- the largest number of individual shipments,
- the largest number of operators,
- the greatest traffic density in an unrestricted right-of-way, and
- the highest average traffic speed.

Cargo tanks are the main carriers of bulk hazardous materials over the roads, although intermodal portable tanks, discussed later in this chapter, are also used. Cargo tanks are usually made of steel or aluminum alloy but can be constructed of other materials such as titanium, nickel, or stainless steel. They range in capacity from about 2,000 to 9,000 gallons depending on road weight laws and the properties (including density, vapor pressure, and corrosiveness) of the commodity or commodities to be

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[70] U.S. Department of Transportation, Materials Transportation Bureau, Research and Special Programs Administration, *A Guide to the Federal Hazardous Materials Transportation Regulatory Program* (Washington, DC: January 1983).

[71] Mark Abkowitz and George List, "Hazardous Materials Transportation: Commodity Flow and Information Systems," OTA contractor report, January 1986.

*A ton-mile is the product of the tons of material carried and the distance carried in miles. For example, a truck with a load of 20 tons that traveled 100 miles would have logged 2,000 ton-miles. Ten trucks each carrying 2 tons and each traveling 100 miles would also have logged 2,000 ton-miles in the aggregate (each truck logging 200 ton-miles).

Table 3-8.—Modal Characteristics of Bulk Shipping of Hazardous Materials

	Highway	Rail	Water
Containers regulated by DOT[a]	Most	All	All
Inspection or testing frequency	Upon manufacture[b]	Upon manufacture plus every 5-10 years[c]	Yearly[d]
Commodity flow data[e]	Very little	Nearly complete	Complete
Regulators and inspectors	RSPA, BMCS, NHTSA[f]	FRA, RSPA, AAR[g]	USCG, RSPA[h]
Fleet size	130,000 cargo tanks[i]	115,600 tank cars[j]	4,909 tank barges[k]
Fleet database[l]	Partial (BMCS)	Yes, complete (AAR)	Yes, complete (ACofE)
Number of operators[m]	260,000	26,000	45,000
Size of load (gals)	4,000-12,000	10,000-30,000	300,000-600,000

[a] Federal regulations cover the transportation of hazardous materials by railcar, aircraft, vessel, and interstate transportation by motor vehicle. Intrastate highway transport of hazardous wastes, hazardous substances, and flammable cryogenics in portable tanks or cargo tanks is also covered (49 CFR 171.1). Unless a State has specifically brought intrastate commerce under regulation, containers in such service need not meet any standards. The Department of Transportation does not know the precise extent to which the States have extended the Federal regulations to intrastate commerce. Most gasoline transport by truck is intrastate and these shipments are a large percentage of the total hazardous materials shipments.

[b] Cargo tanks must undergo an external visual examination every 2 years but generally do not have to be leak tested or pressure tested. However, cargo tanks carrying chlorine must be pressure tested every 2 years and tanks carrying compressed gas (e.g., liquefied petroleum gas) must be pressure tested every 5 years; cargo tanks for flammable cryogenics are inspected prior to each loading. Most tanks, however, are not leak or pressure tested after they are built unless they have been out of service for a year or more, had repairs or modifications performed on them, are operating under an exemption to the regulations, or are used in an area of nonattainment of Clean Air Act standards for ozone. (49 CFR 177.824.)

[c] Tank cars carrying some cargoes are tested more frequently. For example, tank cars carrying chlorine must be tested every 2 years. Also, the frequency of inspection of some tank cars increases to once per year after they are 22 years old. General American Transportation Corp., *GATX Tank Car Manual, 4th Edition* (Chicago, IL: 1979).

[d] 46 CFR 31.10-15, and 31.10-17.

[e] Data on the identity and amount of hazardous materials shipped over the highways is collected by the Bureau of the Census every 5 to 6 years, however the quality and comprehensiveness of the data is poor (see ch. 2). Records of 80 percent of all rail traffic are kept by the Association of American Railroads (AAR). A record of 1 to 6 percent of all rail traffic is kept by the Interstate Commerce Commission. Records of all origins and destinations of hazardous material cargo that travel on U.S. waterways are kept by the U.S. Army Corp of Engineers (ACofE).

[f] The Research and Special Programs Administration (RSPA) develops and publishes regulations on the cargo tanks. The Bureau of Motor Carrier Safety (BMCS) regulates in-use motor vehicles and drivers, and enforces regulations pertaining to the manufacture, marking, repair, etc. of cargo tanks. The National Highway Traffic Safety Administration (NHTSA) has responsibility for the original manufacture of the vehicle.

[g] AAR and the Federal Railroad Administration (FRA) established the basic technical specifications for tank cars. After public rulemaking and comment, RSPA adopts the final specifications in the regulations. Both AAR and FRA inspect tank cars in raill service. Both AAR and FRA inspect tank manufacturers.

[h] For bulk vessels (tank ships and tank barges), the United States Coast Guard (USCG) establishes the regulations, performs the inspections, administers licenses, and specifies the design of vessels. RSPA sets the standards for intermodal portable tanks that can be carried on container ships and barges.

[i] Estimates from the 1977 Truck Inventory and Use Survey. Of these, 38,000 carry hazardous materials 25 to 49 percent of the time, 14,000 carry them 50 to 74 percent of the time, and 67,000 carry them 75 to 100 percent of the time.

[j] Written communication with AAR. This is about 60 percent of the total number of tank cars.

[k] American Waterways Operators. This is the number of inland tank barges, most of which carry hazardous materials. There are also a small number of ocean going barges and tankers that carry hazardous materials, but tank barges are responsible for most inland traffic.

[l] While the Army Corp of Engineers (ACofE) keeps track of the number of active and inactive vessels that may carry hazardous materials in U.S. commerce, and the AAR's UMLER file lists all tank cars by DOT specification that are in service, there is no comparable database for the highway mode. Although individual companies know how many and what types of cargo tanks or intermodal portable tanks they have, no single agency has an accounting of all bulk highway vehicles nationwide.

[m] "Operator" refers to the vehicle or vessel "driver." The number of people driving cargo tanks (carrying hazardous materials) is estimated by assuming there are two drivers per cargo tank. Large interstate private carriers often have three or more drivers per vehicle, while other carriers typically have fewer. Information on the rail mode was obtained from AAR and on the water mode from USCG. The number presented in the water mode represents all those licensed by USCG to operate commercial vessels; most of these would not routinely be involved with hazardous materials.

SOURCES: Unless otherwise indicated in footnotes, Office of Technology Assessment, based on information from participants of workshops and panel meetings or comments to draft reports by the affected parties.

carried. Federal road weight laws usually limit motor vehicle weights to 80,000 pounds gross. Some States, however, allow higher gross weights, and in these States cargo tanks can have larger capacities. Table 3-9 lists the primary contemporary specification for cargo tanks and examples of commodities each type of cargo tank might carry.

All newly constructed cargo tanks must meet current specifications, which prescribe the requirements for the thicknesses of the bodies of the tanks, pressure relief devices, manhole covers, gauging devices, overturn protection, pressure test methods, and other features affecting safety. However, older specification tanks—for example, an MC-304 or an MC-311—may still be used to carry hazardous materials, even though it does not meet current requirements.

The nature of the bulk trucking business differs from that of rail or water bulk transport in that there are many more carriers of a wider variety and businesses are generally much smaller. The carriers include private interstate carriers; large interstate common and contract carriers; and small common, contract, and private intrastate carriers.* The quality of the equipment varies within each of these groups, but generally the large private interstate transporters have the newest equipment and the small intrastate private carriers have the oldest, with the common carriers somewhere in between.

Turnover of equipment is slow, and cargo tanks generally go through several tiers of owners. Large private interstate carriers, primarily large petrochemical companies, have the resources to purchase new equipment and maintain it well. They use their trucks around the clock 6 to 7 days a week. After 8 to 10 years, when maintenance becomes uneconomical because of downtime for repairs, they sell the cargo tank to another firm, usually a smaller one with fewer resources. The second-tier owner uses it until it becomes uneconomical and sells it to yet another owner. The useful life of a cargo tanker used to transport fuels can easily exceed 20 years.

Cargo tanks carrying some corrosive commodities have much shorter lifespans. According to one tank truck company safety director his "acid tanks are junk" after 4 years.[72] In the past, a carrier frequently dedicated some of his fleet to carrying particular commodities. While this practice minimized corrosion and incompatibility problems, it often meant that the cargo tanks returned empty after delivering the product. In recent years, economic pressures have forced carriers to reduce the number of

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*Private carriers transport commodities that they own and the transport is integral to their business. Common carriers are transporters of freight for compensation; common carriers must accept all traffic tendered to them that is within their operating authority (to the extent that they have equipment and drivers to do so). Contract carriers are transporters of freight by motor vehicle for compensation in the exclusive service to one or more specific shipper(s) as authorized by duly constituted Federal or State authority. This classification includes owner-operators under long-term lease to certificated carriers.

[72] National Tank Truck Carriers, Inc., National Tank Truck Safety Seminar, St. Louis, MO, Apr. 14-15, 1986.

Table 3-9.—Cargo Tank Table

Cargo tank specification number[a]	Types of commodities carried	Examples
MC-306 (MC-300, 301, 302, 303, 305)	Combustible and flammable liquids of low vapor pressure	Fuel oil; gasoline
MC-307 (MC-304)	Flammable liquids, Poison B materials with moderate vapor pressures	Toluene diisocyanate
MC-312 (MC-310, 311)	Corrosives	Hydrochloric acid; caustic soda solution
MC-331 (MC-330)	Liquefied compressed gases	Chlorine, anhydrous ammonia, LPG
MC-338	Refrigerated liquefied gases	Oxygen, refrigerated liquid; methane, refrigerated liquid

[a] The number in parenthesis designates older versions of the specification; the older versions may still be operated but all newly constructed cargo tanks must meet current specifications.

SOURCE: 49 CFR 172.101 and 178.315 to 178.343.

Photo credit: *Waste Age Magazine*

An MC-312 cargo tank delivers hazardous waste to a treatment plant. MC-312s typically carry corrosive commodities.

dedicated trucks and to seek return-trip loads (backhauls) whenever possible. Backhauls often necessitate cleaning the tank between loads to accommodate different products, thus subjecting the tank to additional wear, increasing pitting and corrosion, and shortening its lifespan.

Regulations and Intrastate Trucking.—The extent of Federal regulatory coverage for the highway mode is fundamentally different from that for rail and water modes, where all commerce is subject to Federal hazardous materials regulations. Under the predecessor statute to the Hazardous Materials Transportation Act, only interstate commerce was regulated, and this restriction was maintained when DOD issued revised hazardous materials regulations in 1976.[73] However, because a large percentage of hazardous materials truck transport is in intrastate commerce, with gasoline, fuel oil, and propane deliveries comprising the bulk of it, the question of applicability of Federal regulation is important.[74]

Except for those transporting certain materials,[75] carriers operating solely intrastate need not meet Federal standards, unless the State in which they do business has similar regulations. In some States, intrastate carriers have become the market for used equipment that no longer meets Federal standards. Moreover, new tanks built solely for intrastate trade need not meet DOT specifications, because those specifications are not applied. Such tanks also do not need to meet the periodic retest and maintenance requirements prescribed in the Federal rules. The noncompliance of these tanks with Federal standards has caused administrative problems for some States implementing the Federal rules.[76] In addition, intrastate carriers have no obligation to report releases of hazardous materials to RSPA, even if they are under State regulation in other respects. This alone makes the Federal spill and accident reporting system incomplete, a problem further documented in chapter 2.

The extent to which individual States have applied 49 CFR to intrastate commerce is an open question. In conversations with Federal and State regulators, shippers, and representatives of major bulk carriers, OTA found widespread disagreement over the degree to which Federal hazardous materials regulation has been extended to intrastate traffic. RSPA officials state that 49 CFR does not apply to all intrastate highway traffic and that some cargo tanks were never built to Federal specifications because they were for use only in intrastate commerce.[77] Carrier representatives and BMCS staff counter that States participating in the Motor Carrier Safety Assistance Program must apply 49 CFR in motor vehicle inspections for all hazardous materials traffic, both intrastate and interstate.[78]

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[73] U.S. Department of Transportation, Docket No. HM-134, 41 *Federal Register* 38175, Sept. 9, 1976.

[74] About 55 percent of the hazardous materials transported over the highways is intrastate in South Dakota, for example. See U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, March 1986). Gasoline comprises a large percentage of hazardous materials shipments over the highway and most gasoline deliveries are intrastate. About half of all gasoline is delivered by large interstate oil companies that are subject to Federal regulations. Much of the rest of the gasoline is delivered by intrastate operators.

[75] 49 CFR 171.1. Hazardous wastes, hazardous substances, and flammable cryogenics comprise the only groups of hazardous materials whose transport is regulated by the Federal Government regardless of whether the commerce is intrastate or interstate.

[76] In the State of Washington, of all heavy truck accidents involving hazardous materials from 1979 to 1983, 64 percent involved private intrastate carriers of hazardous materials, unregulated by both the State and the U.S. Department of Transportation. The Utilities and Transportation Commission notes that the private carriers' terminals are not subject to survey, his driver records are not subject to review, and his safety record is known only to himself. The continually violating private carrier cannot be removed from the highway, nor does he face any deterrent to violation in the form of administrative penalty. Washington Utilities and Transportation Commission, *Summary and Analysis, Heavy Truck-Hazardous Materials Accidents 1982-1983* (Olympia, WA: 1983), p. viii.

[77] James O'Steen in U.S. Congress, Office of Technology Assessment "Transcript of Proceedings—OTA Workshop on State and Local Activities in the Transportation of Hazardous Materials," unpublished typescript, May 30, 1985; and Alan Roberts, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Transportation of Hazardous Materials Advisory Panel Meeting," unpublished typescript, Washington, DC, Jan. 24, 1985.

BMCS has records of the States that have adopted 49 CFR, but not of the numerous variations to it enacted by many States. Moreover, adoption of 49 CFR by a State does not mean that intrastate highway commerce will be regulated. For example, the State of Washington adopted 49 CFR in 1978, and based on BMCS records, Washington regulates intrastate transport of hazardous materials. However, according to the Public Utilities Commission of the State of Washington, the State legislature did not decide to regulate private intrastate transport of hazardous materials until 1985.[79] Since the new State regulations will not be promulgated until summer 1986, this transport is still unregulated.

MC-306 Tank Trucks.—The large volume of gasoline carried by MC-306 tank trucks, making over 40,000 daily deliveries to retail service stations in every locality in the country, is a primary reason that truck transportation of gasoline is responsible for more deaths, injuries, and property damage than all other hazardous materials in transportation. Most of the hazardous material highway deaths in recent years (five out of eight in 1983) have been the result of gasoline truck accidents, and many of the worst incidents are the result of tank truck rollovers

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[78] Clifford Harvison and Al Rosenbaum, National Tank Truck Carriers, Inc., and Merritt Sargent, Bureau of Motor Carrier Safety, personal communications, March 1986.

[79] Don Lewis, Rail and Motor Carrier Training Officer, Washington Utilities and Transportation Commission, personal communication, Mar. 21, 1986.

Photo credit: Modern Bulk Transporter

MC-306 tank trucks transport the most prevalent hazardous material, gasoline.

and leakage of hundreds to thousands of gallons of gasoline.

The design of the MC-306, the most common cargo tank, may be an important factor in the truck's frequent involvement in accidents. The MC-306 has a high center of gravity and consequently high rollover susceptibility. Industry and academic research efforts have produced several new designs to improve the safety performance of the MC-306.

For example, the University of Michigan's Highway Safety Research Institute (HSRI) proposed a new design of large cargo tank semi-trailers for use in Michigan.[80] The basic change from the standard MC-306 is an increase in the maximum width of the tank and chassis from 96 to 102 inches to allow a wider track and permit a lower center of gravity. The increased size allows the tanker combination to carry more gasoline, but also increases the gross weight. Designs with three, four, or five semi-trailer axles are needed to keep the load per axle within Michigan's legal limits. HSRI estimates that the improved stability and fewer trips of the larger vehicle would result in a 40-percent reduction in the single-vehicle-accident rollover frequency.

The Fruehauf Corp. has applied similar principles to a tri-axle trailer design that is much closer to existing tanker design, although the tank center of gravity is about 11 inches lower than that of existing units. This change makes the vehicle one-half as likely to be involved in a rollover. A prototype vehicle has been constructed and has been tested in service for at least 30,000 miles by different oil companies, and several major oil companies are purchasing some of these new trailers for use in Louisiana, where weight laws allow them to operate. The Fruehauf design has a capacity about 550 gallons greater than the standard MC-306, and this difference was very important in the decision to purchase them. A new design that did not have at least the capacity of current models would not be attractive to carriers, as many carriers use their cargo tanks so extensively that a difference in capacity of several hundred gallons is significant.

These truck designs require consideration of a number of trade-offs. Both involve gross truck and trailer weights above the 80,000 pounds currently allowed on most of the Nation's highways. The Michigan tankers range up to 125,000 pounds, and the Fruehauf truck weighs about 86,000 pounds. Accordingly, widespread use of these or similarly designed tankers depends on whether other States are willing to approve heavier truck weights on their roads. An increase in truck weights accelerates the damage rate to road surfaces. Moreover, the new designs employ a 102-inch-wide wheel base. While this width is allowed on all Interstate and primary roads, many urban areas do not permit trucks of that width to operate in their jurisdictions. Access restrictions facing the wider cargo tankers are important factors in decisions about purchasing such vehicles. Finally, accidents involving trucks with increased load capacities have potentially more serious consequences than those involving current trucks.

The safety benefits derived from a design change would be proportional to the percentage of the fleet having the new design, and any major design change will likely be implemented gradually, as older cargo tanks are taken out of service. RSPA has estimated, in a cost-benefit analysis, that if $1 million were expended for each annual gasoline tanker death (where the death was due to the gasoline), the amount available to make safety modifications in all existing gasoline trucks would be about $200 per truck per year. If the average lifespan of a cargo tank is 20 years, then about $4,000 would be available per truck, a figure that is close to the price difference between the old design and some new ones. Decreases in injuries, property damage, and deaths that are attributable to the vehicle accident rather than to the hazardous nature of the cargo (the latter are the only deaths that RSPA notes in its incident reports) would be additional benefits. OTA's independent calculations suggest the benefits may be substantially larger and the trade-off time may be much less (box 3H), although admittedly much uncertainty exists for several of the estimates used in calculating the costs and benefits of a design change.

Three cargo tanks built to a new design, employing fiberglass reinforced plastic (FRP), are being used for gasoline transport on a trial basis.[81] The FRP tanks, built in the United Kingdom, have better im-

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[80] R.D. Ervin, et al., *Future Configuration of Tank Vehicles Hauling Flammable Liquids in Michigan* (Ann Arbor, MI: University of Michigan Highway Safety Research Institute, December 1980). This research organization is now called the University of Michigan Transportation Research Institute.

[81] George Jennings, Mobil Oil Corp., Fairfax, VA, personal communication, March 1986.

Box 3H—Trade-offs Associated With a Changeover to Low Profile Gasoline Cargo Tankers

OTA performed a crude analysis of cost and benefit factors for a major redesign of the common gasoline tanker, the MC-306, to a low profile trailer tank, one-half as susceptible to rollover.

Cost factors include:

- the price difference between a regular MC-306 and a low profile trailer, and
- the number of MC-306s in use.

Cost factors not taken into account include:

- difference in payloads. (A reduction in payload would increase the cost of the changeover. The increased number of trips needed to deliver the same amount of gasoline would increase the exposure to accidents. Most proponents of a major redesign of the MC-306 suggest that the payload must be kept equivalent or increased to make a changeover acceptable to industry.)

Benefit factors include:

- reduction in rollovers of MC-306s per year,
- avoidance of accident cost for MC-306s,
- reduction in the number of deaths due to rollovers involving MC-306s, and dollar value of life.

Cost difference between a standard MC-306 and a low profile design is approximately $5,000. Because of investment tax credits and depreciation schedules the true cost would be approximately 20 to 25 percent less than the incremental cost. A 20 percent adjustment is used in these calculations.

It is presumed that all cargo tanks will not be replaced at once, but rather that after their useful life is over, they will be replaced with the low profile cargo tank. The effects of inflation are ignored. If inflation affects the costs and benefits similarly, there would be little net effect.

Approximately 55,000 MC-306 cargo tanks are currently in service. Total cost to the industry to replace all MC-306s is thus:

Cost = (55,000 tankers)($4,000/tanker) = $220 million

Current number of rollovers = 225/yr

The results of the Michigan tanker study were extrapolated on the basis of population to arrive at a total of 225 rollovers annually nationwide.[1] This figure was derived from a model based on extensive accident experience of all types of vehicles but assumes that all gasoline is delivered in the standard MC-306 in a tractor-trailer configuration. The estimate does not take into account the use of the full-trailer configurations, which would tend to have a higher involvement in rollover accidents. This figure includes both interstate and intrastate traffic. A similar extrapolation of 1984 data contained in an Oregon Public Utility Commission report resulted in an estimate of 277 rollovers per year nationwide. The full-trailer configuration was included in the Oregon estimate.

Current cost per accident = $35,000 to $70,000

The average cost of a cargo tank noncollision accident in 1977 was $20,000 according to the U.S. Department of Transportation (DOT) 1980 study.[2] The $35,000 to $70,000 range takes into account inflation since 1977 and the increased attention paid to the environmental effects of a spill, leading to more extensive cleanups. The costs of some rollover accidents could be much greater than this range depending on the location of the spill and whether there was a fire or explosion. The cost to public agencies in responding to accidents is not included in this estimate. The average of the range, $52,000, will be used in calculation of benefit.

Deaths per year = 16 to 160

The DOT study cited above contains data that indicates there are between 0.07 to 0.7 deaths per cargo tank rollover accident[3] (this would include deaths not attributable to hazardous materials). The lower value came from the Bureau of Motor Carrier Safety (BMCS) accident records from a single year (1977) and the higher figure from a subset of 4 years of BMCS data (1976-80). The average of the range, 88 deaths per year, will be used in the calculation of benefit.

Value of life = $1,000,000

Various Federal agencies have more or less assigned values ranging from $500,000 to $2,000,000.

Benefit = one-half [(225 rollovers/yr)($52,000/rollover) +(88 deaths/yr)($1,000,000/death)] = $50 million/yr

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[1] R. D. Ervin, et al., *Future Configuration of Tank Vehicles Hauling Flammable Liquids in Michigan*, UM-HSRI-80-73-1 (Ann Arbor, MI: The University of Michigan, Highway Safety Research Institute, December 1980).

[2] L.H. Tyndall, et al., *Cost Effective Methods of Reducing Leakage Occurring in Overturns of Liquid-Carrying Cargo Tanks* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, September 1980), p. 9-2.

[3] Ibid., pp. 9-3 and 9-10.

Approximately one-half of all rollovers would be avoided using the new design. Injuries are ignored; they are about four to seven times as common as deaths. Avoided injuries would add to the benefit.

Based on these figures, it would take 4.4 years for the investment in safer equipment to pay for itself via reduced accident expenses ($220 million/$50 million/yr = 4.4 yr). The average useful lifespan of an MC-306 cargo tanker is at least 20 years.

Results of our analysis show that the costs and benefits are of comparable magnitudes and that the breakeven point lies well within the expected lifespan of the cargo tanker. A more rigorous analysis of the safety and economic impacts associated with a major redesign of the MC-306 cargo tanker would be useful. The estimates of costs of rollover accidents and the reduction in the number of deaths after adoption of the new design need refinement.

pact resistance, fire resistance, and lower rollover susceptibility than the standard aluminum MC-306. The three models on the road currently, however, have a higher tare (container) weight than most MC-306s and thus cannot carry as much gasoline. Unless the weight of the FRP tank can be reduced, it will not be widely used because of road weight law restrictions.

OTA analysis shows that highway common carriers experience the highest frequency of releases with corrosives (see chapter 2). Because they are relatively unreactive chemically, plastics and composite materials also have potential for use in cargo tanks carrying acids and corrosives, which quickly degrade metal cargo tanks. A U.S. manufacturer received DOT approval to build a composite tanker and has constructed a prototype. However, more research is needed on the durability and road-worthiness of the tankers before carriers will invest in them. Current research, sponsored jointly by RSPA and BMCS, into tank truck corrosion problems should address significant industry and safety concerns. Results are expected in late 1986.

Changes to Cargo Tank Regulations.—The number of cargo tanker releases reported to RSPA averaged over 1,500 per year from 1976 through 1984, although as indicated in chapter 2, OTA finds this figure to be an underestimate. Both human and mechanical factors affect the highway spill rate. In its studies of cargo tank safety, DOT has identified widespread deficiencies in the design and maintenance of cargo tanker manhole covers, pressure relief valves, and vents.[82] One study found leaks in every compartment of the 20 cargo tanks tested, primarily in the areas cited above, and many of the manhole covers used on cargo tanks constructed in the 1960s and 1970s are unable to withstand the forces of a rollover and leak their contents whenever a rollover occurs.

No single governmental agency or industry group knows with any precision how many of the different types of tank trucks are in use,* kinds of commodities carried in them, and the classifications of the carriers using the trucks. Requiring registration of each tank truck on manufacture and submission of sale records for the tanker could give DOT much of this information. If tied to an inspection program and better reporting of accidents and releases, such information could help identify inadequacies in tank designs and would be useful in evaluating changes to regulations.

Problems with the maintenance of cargo tankers are well documented, and many of the problems and appropriate corrective measures could be identified through regular tests or inspections. Although pressure testing and inspection of containers are important safety tools, DOT requires periodic pressure testing of only some cargo tanks after construction.**

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[82] Dynamic Science, Inc., *Cost-Effective Methods of Reducing Leakage Occurring in Overturns of Liquid-Carrying Cargo Tanks* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, September 1980); and U.S. Department of Transportation, Federal Highway Administration, *Integrity of MC 307/312 Cargo Tanks* (Washington, DC: October 1984).

*The U.S. Department of Transportation (DOT) does know how many MC-338 cargo tanks there are. The trucks carry flammable cryogenic cargo (e.g., liquefied carbon monoxide) and comprise a very small portion of the cargo tank fleet. The highly hazardous nature of the cargo carried in them has led DOT to extend regulation to intrastate carriage and to create a special registry for these trucks.

**MC-331 and 338 cargo tankers that typically carry anhydrous ammonia, liquefied petroleum gas, and cryogenic liquids are required to be pressure tested. These tanks, if covered by Federal or State regulations must be tested every 5 years (every 2 years if used for chlorine transport). All other cargo tanks must undergo an external visual examination every 2 years and the inspection can be made by the operator. Gasoline cargo tanks in regions of air quality nonattainment are required by the Environmental Protection Agency (EPA) to have annual leak tests. Most States have some areas of nonattainment, commonly metropolitan areas. EPA does not keep track of the tanks required to be leak tested, leaving the implementation of the regulation to the States.

After 10 years of study, DOT has issued a Notice of Proposed Rulemaking (NPRM) for cargo tankers[83] calling for, among other things, annual pressure tests of all cargo tanks under Federal regulation. The rulemaking would greatly increase the number of cargo tanks that must be pressure-tested and would also increase the frequency of such tests. More effective pressure relief valves would be required, and many gasoline cargo tanks would have to be retrofitted with stronger manhole covers.

At a public hearing on NPRM, several industry groups expressed concern that the rulemaking would have unintended deleterious results, particularly in the areas of MC-306 body construction, tank truck inspection costs and pressure relief valve design. Rigorous estimates of increased costs under the proposed regulations were developed by industry for submission to DOT in May 1986.

Roadside inspections of vehicles carrying hazardous materials have shown that problems with the vehicles themselves—faulty brakes, tires, or lights—are more frequently the cause of accidents than are problems with the hazardous materials container itself. Increased attention to maintenance practices would help reduce accidents caused by faulty equipment.

Improving Driver Performance.—Many of the most serious hazardous materials releases during bulk transport over the highway are caused by vehicle accidents, most of them the result of driver error.[84] Improving driver performance could thus increase safety. Methods of accomplishing this include both improving equipment and improving driver training. The Shell Oil Co., employing both techniques, has experienced a 58-percent reduction in its preventable vehicular accident rate over the course of its driver safety training program instituted in 1979.[85] (See table 3-10.)

The program entails several days of instruction in relevant hazardous materials regulations and vehicle operating procedures, followed by 1 or 2 weeks of field training, during which each driver is accompanied on the job by an instructor. Each of the trucks owned by Shell has a tachograph that automatically records when the motor starts, when motion starts, travel speeds, when the truck stops, distance between stops, total distance traveled, and the duration of all trips. The tachograph records make each driver aware that he is accountable for his performance, that his driving behavior can be readily evaluated. He also knows that the records can work to his benefit in the case of an unavoidable accident.

The Insurance Institute for Highway Safety (IIHS) has recommended that tachographs be required on all large trucks. Furthermore, the IIHS holds that speed limiters should be placed on trucks, better braking systems should be employed, and that recapped tires should not be allowed on front wheels. Tire failures follow brakes as the leading equipment-

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[83] U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau, *Federal Register*, Notice of Proposed Rulemaking, Requirements for Cargo Tanks, vol. 50, No. 180, Sept. 17, 1985.

[84] Abkowitz and List, op. cit.

[85] Shell Oil Co., personal communication, January 1986.

Table 3-10.—Major Oil Company, Total Vehicle Accidents (safety programs begun in 1979)

	Number		Rate[a]		Number of serious incidents involving					
					Fire		Rollover		Spill[b]	
Year	TOT VEH ACC[c]	Total PVA[d]	TOT VEH ACC	Total PVA	NPVA[e]	PVA	NPVA	PVA	NPVA	PVA
1979	236	82	7.14	2.48	2	0	0	1	0	0
1980	222	74	7.19	2.40	0	0	3	1	0	0
1981	185	71	7.18	2.73	1	1	1	1	0	0
1982	144	39	5.96	1.62	0	0	2	0	0	0
1983	120	46	5.08	1.95	0	0	0	0	1	0
1984	115	21	5.68	1.04	1	0	0	0	0	0
1985	—	—	—	—	0	0	0	0	1	0

[a] Rate is the number of accidents per 1 million vehicle miles.
[b] These are spills other than those associated with fires or rollovers.
[c] TOT VEH ACC—total vehicle accidents.
[d] PVA—preventable vehicular accidents, an accident where the driver failed to do everything possible to avoid the accident.
[e] NPVA—nonpreventable vehicular accidents.

SOURCE: Private written communication to Office of Technology Assessment staff.

related causes of truck crashes.[86] A pilot project could be developed to equip a number of trucks with such safety equipment and carefully monitor the safety performance of the fleet. Any change in accident rates and severity would permit evaluation of equipment's contributions to safety.

Coordination Among Federal Agencies.—Improving coordination among agencies currently regulating motor carriers is also essential. Responsibilities are currently spread over three agencies:

- RSPA—container specifications, marking and labeling, and placarding;
- BMCS—inspecting cargo tank manufacturers and motor carrier operating procedures; and
- National Highway Traffic Safety Administration—manufacture of vehicles.

Difficulties in coordinating activities and sharing accident data have resulted in disjointed and often ineffective regulation. For example, both RSPA and BMCS support accident databases, but there are few cross-checks made between them. Perhaps more importantly, specifications for cargo tanks have been developed separately from specifications for the motor vehicles on which the tanks are mounted. Thus, all components of the transportation system (including container, load, vehicle, and highway) have not been considered in developing design standards. For example, studies of a tank truck's interaction with the road system have shown that the truck's stability and resistance to rollover is dependent on such factors as the center of gravity, height, track width, suspension, fifth-wheel characteristics, and the tires of the vehicle; yet these factors are not a part of RSPA's cargo tank specifications.*

Compounding the difficulties in implementing design or technological innovations is the fact that no single trucking industry group exists to consider such issues for the cargo tanks used in truck shipments of hazardous or other materials. The Truck Trailer Manufacturers Association has a committee dealing with tank trucks and the National Tank Truck Carriers, Inc., serves some of the for-hire tank truck industry. The American Trucking Associations, the American Petroleum Institute, and other groups also have an interest in such issues. Achieving consensus on decisions affecting tank truck designs is thus a difficult and lengthy process.

Rail Tank Cars

Rail shipments account for about 5 percent of the tonnage of hazardous materials transported annually with about 3,000 carloads shipped each day. (See chapter 2.) The numbers of daily shipments are far fewer than those made by highway, and the shipments are transported by a much smaller number of carriers. Most of the ton-miles are logged by just 9 of the 25 Class 1 railroads doing business in 1985; Class 2 and Class 3 railroads carry few hazardous materials.[87]

OTA analysis of RSPA and Federal Railroad Administration (FRA) data indicates that, on a ton-mile basis, the rail mode has a lower release rate than the highway mode and a somewhat higher rate than the water mode. (See chapter 2.) However, modal differences such as the number of miles of network, traffic density, and average speed affect the release rates in each mode, making direct modal comparisons difficult. Moreover, the rates themselves are questionable, as documented in chapter 2.

As all hazardous materials rail traffic falls under Federal regulations, all rail containers are required to be of the proper specification regardless of the origin, destination, or duration of the trip or characteristics of the shipper or carrier. About 80 percent of annual rail shipments of hazardous materials involve tank cars, which have useful lives of 30 to 40 years. Since 1970, the capacity of tank cars for carrying hazardous materials has been limited to 34,500 gallons or 263,000 pounds gross weight (weight of tank car and commodity).

The two main categories of tank cars are pressure and nonpressure, and different tank car designs accommodate both gases and liquids. Each category has several classes that differ from each other in such

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[86] Anne Fleming (ed.), *Big Trucks and Highway Safety* (Washington, DC: Insurance Institute for Highway Safety, 1985), p. 14.

*A stability requirement for cargo tankers need not specify any particular arrangement of tires or suspension, but might require tilt-table tests to evaluate the rollover stability of different designs. Tilt-tables are platforms on which a truck or cargo tank can be placed and tilted sideways until the wheels on one side lift off the platform. The angle to which the tilt-table must be raised before the truck wheels lift off is a measure of the static stability of the configuration being tested.

[87] Jim Reiter, American Association of Railroads, personal communication, March 1986. A Class 1 railroad has gross revenues greater than $87.935 million; a Class 2 between $17.587 and $87.935 million; and Class 3 less that $17.587 million.

Photo credit: Association of American Railroads

A pressure tank car, DOT 112J, transports liquefied petroleum products.

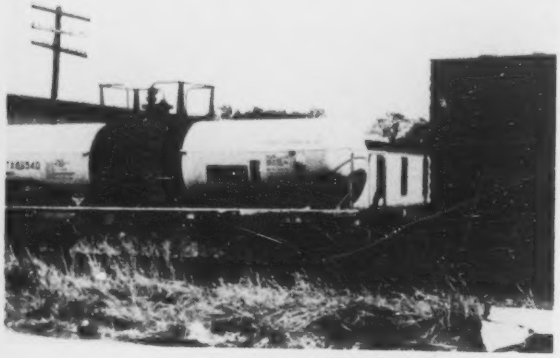

Photo credit: Association of American Railroads

An example of a nonpressure tank car, a DOT 111, used in this case to transport aqueous hydrofluoric acid.

things as test pressure, presence or absence of bottom discharge valves, type of pressure relief system, and type of thermal shielding. Ninety percent of tank cars are made of steel; aluminum is the second most common construction material. The thickness of the tank car shell is specified by regulation (see table 3-11).

Tables 3-12 and 3-13 list the common classes of tank cars of both categories and provide examples of typical cargo that each may carry. Approximately 66 percent of the rail tonnage consists of chemicals, and approximately 23 percent consists of petroleum products. Based on DOT's hazard classification scheme, the most common commodities are flammable liquids and corrosive materials, each accounting for about 25 percent of the tonnage.[88]

DOT prescribes tank car design specifications in 49 CFR Part 179. The specifications have generally been developed from industry standards adopted by the Tank Car Committee of the Association of American Railroads (AAR). AAR, an industry organization, is involved in all aspects of railroad operations, including evaluation of new tank car designs, inspection of manufacturers, and collection and analysis of accident data. In addition, the Mechanical Division of AAR participates in the approval of tank car designs, materials, and construction, as well as the conversion or alteration of tank cars.[89] Although AAR approves all new tank car designs prior to acceptance by FRA and RSPA, RSPA is not involved in the design approval activities of AAR and is not permitted to attend sessions where the designs are analyzed and evaluated. RSPA's exclusion from these sessions makes it difficult for the agency to evaluate requests for special waivers or exemptions to design requirements. After tank cars are constructed, qualification, maintenance, and use is governed by Section 173.31, as well as by individual commodity sections of the regulations. FRA is responsible for inspecting railroad operations and tank car manufacturers.

In the mid-1970s, a series of derailments occurred, one involving the puncture of flammable gas tank cars by the couplers of adjoining cars. The ignited material venting from the punctured car impinged on other derailed flammable gas cars, simultaneously heating and expanding their contents beyond the capacity of safety relief devices and weakening the tank shells. The resulting explosions and fires caused enormous damage.

Recommendations made prior to 1978 by the National Transportation Safety Board (NTSB) and investigations by the Federal Railroad Administration led DOT to mandate installation of top and bottom shelf couplers that would be less likely to disengage and puncture adjacent cars.[90] For flamma-

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[88] Abkowitz and List, op. cit.

[89] See 49 CFR 179.3.

[90] National Transportation Safety Board recommendations R-74-033 (October 1974) and R-75-19 (April 1975).

Table 3-11.—Minimum Tank and Jacket Plate Thickness

Minimum plate thickness after forming	Common use of plate thickness
Steel:	
11 gauge (approximately 1/8 inch) also aluminum	Jacket of insulated tank cars; or jacket for thermally protected cars.
7/16 inch	Tank for nonpressure tank cars; jacket for nonpressure tank within a tank; or shell portion of jacket for cryogenic liquid tank cars.
1/2 inch	Head puncture resistance (head shield); or head portion of jacket for cryogenic liquid tank cars.
9/16 inch	Tank for steel pressure tank cars with tank test pressures of 200 psi and below.
11/16 inch	Tank for steel pressure tank cars with tank test pressures of 300 psi and greater.
3/4 inch	Tank for steel pressure tank cars in chlorine service.
Aluminum:	
1/2 inch	Tank for nonpressure aluminum tank cars.
5/8 inch	Tank for aluminum pressure tank cars.

SOURCE: Charles J. Wright and Patrick J. Student, Union Pacific Railroad, "Tank Cars," unpublished typescript, no date.

Table 3-12.—Common Pressure Tank Cars

Class	Material	Insulation	Test[a] pressure	Valve[b] setting	Notes
DOT 105	Steel/ aluminum	Required	100	75	No bottom outlet or washout; only one opening in tank; e.g., DOT 105 A 500W = chlorine[c]
			200	150	
			300	225	
			400	300	
			500	375	
			600	450	
DOT 112	Steel	None	200	150	No bottom outlet or washout; e.g., DOT 112J 400W = anhydrous ammonia[d]
			340	225	
				280.5	
			400	300	
				330	
			500	375	
DOT 114	Steel	None	340	255	Similar to DOT 105; optional bottom outlet; e.g., DOT 114 T 400W = LPG
			400	300	

[a] Pressure in psi to which the tank car is tested upon manufacture and periodically thereafter.

[b] Setting at which pressure relief value will start to discharge. Tank cars may also be equipped with vents; the vents would operate when the pressure inside the tank reached the test pressure.

[c] "DOT 105" specifies the general class; "500" specifies the tank car test pressure; the "W" indicates the method of welding of the tank; and, a number, if present after the "W", indicates specific fittings, materials, or linings.

[d] The "J" indicates that the tank car has jacketed thermal protection. A "T" would indicate the presence of spray-on thermal protection. Both "J" and "T" indicate that the tank car is equipped with head shields.

SOURCE: Charles J. Wright and Patrick J. Student, Union Pacific Railroad, "Tank Cars," unpublished typescript, no date.

ble gas, anhydrous ammonia, and ethylene oxide tank cars, the agency also required installation of head shields as further protection against coupler damage, and the addition of thermal protection to prevent rapid overheating if a neighboring tank car were on fire. AAR, its Tank Car Committee, FRA, and RSPA with participation by the Railway Progress Institute (RPI), the rail manufacturers, jointly established these tank car modifications, which have greatly improved the safety of bulk movement of hazardous materials by rail.

After the retrofits of the DOT 112/114 tank cars* were completed during 1981, the number of railroad accidents involving disastrous releases of flammable gases decreased dramatically. A 1981 study by AAR and RPI showed that the frequency of head punctures for retrofitted tank cars decreased by 95 percent from the preretrofit rate, and the frequency

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*These tank cars are pressure cars that carry flammable gases—for example liquefied petroleum gas—and nonflammable gases, such as anhydrous ammonia.

Table 3-13.—Common Nonpressure Tank Cars

Class	Material	Insulation	Test[a] pressure	Valve[b] setting	Notes
DOT 103	Steel/aluminum Stainless steel/ nickel	Optional	60	35	Optional bottom outlet DOT 103 DW = whiskey
DOT 104	Steel	Required	60	35	Similar to DOT 103; optional bottom outlet
DOT 111	Steel/aluminum	Optional	60	35	Optional bottom outlet and bottom washout
	—		100	75	DOT 111A 60W5[c] = corrosive hydrochloric acid DOT 111A 60W1 = gasoline

[a] Pressure in psi to which the tank car is tested upon manufacture and periodically thereafter.
[b] Setting at which pressure relief valve will start to discharge. Tank cars may also be equipped with vents; the vents would operate when the pressure inside the tank reached the test pressure.
[c] The "DOT 111" is the class; the "60" is the pressure; the "W" indicates the type of welding construction; and the "5" indicates that the tank is rubber lined.

SOURCE: Charles J. Wright and Patrick J. Student, Union Pacific Railroad, "Tank Cars," unpublished typescript, no date.

of thermal ruptures dropped by 93 percent.[91] Experience since that study shows that while the shelf couplers tend to keep the cars more securely attached to one another, which results in more car derailments per accident, they have continued to prevent punctures and ruptures.[92] All DOT 111A tank cars carrying flammable gases and ethylene oxide and DOT 105 tank cars will be retrofitted with head shields and thermal protection by December 31, 1986. Because of the efficacy of the shelf couplers, all hazardous materials tank cars are now being fitted with them.

Table 3-14 lists the periodic inspection and test requirements for several common tank cars. Typically, the tank must be pressure tested every 5 to 10 years, although for some commodities—chlorine, for example—the tests are much more frequent. For some tank cars, the frequency of inspection increases as the car ages. In addition, some shippers inspect their cars more frequently than regulations demand, often prior to each loading.[93]

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[91] American Association of Railroads, *Effectiveness of Shelf Couplers, Head Shields and Thermal Shields on DOT 112 (114) and 105 Tank Cars*, Railway Progress Institute—American Association of Railroads Tank Car Safety Project Report RA-01-5-51 (Washington, DC: June 13, 1985).

[92] Charles Batten, National Transportation Safety Board staff, personal communication, 1984.

[93] Robert Christman, Mobay Chemical Corp. and Hugo Andricain, Dow Chemical U.S.A., personal communication and demonstration, October 1985.

Table 3-14.—Retest Requirements for Selected Tank Cars

	Retest interval years				Retest pressure—psi		
	Tank and interior heater systems					Safety relief valve	
Specification	Up to 10 years	Over 10 to 22 years	Over 22 years	Safety relief valve	Tank	Start-to-discharge	Vapor tight
103DW	5[a]	3	1	([b])	60	35	28
105A500W ...	10[c d]	10[c d]	10[c d]	5[c e]	500	375[f]	300
111A60W1 ...	—	20[g]	10	10	60	35	28
111A60W5 ...	5[d]	3	1	None	60	—	—
112A400W[h] ...	10	10	10	5	400	300	240
114A400W ...	10	10	10	5	400	300	240

[a] A commodity for which a tank is approved may be used when retesting tanks in service not over 10 years
[b] Safety relief valve retest period is same as tank retest period.
[c] Tanks and safety relief valves in chlorine service must be retested every 2 years at any time during the calendar month the retest falls due.
[d] Nickel clad tanks in bromine service and any glass, rubber, or lead lined tank need not be periodically retested, but the interior heater systems and safety relief valves must be retested at the prescribed interval.
[e] Safety relief valves in bromine service must be retested every 2 years.
[f] If safety relief valves are used in combination with breaking pins designed to break at 375 psi, the safety relief valves must be retested and must start to discharge at 360 psi plus or minus 3 percent.
[g] Retest period for interior heater systems on cars so equipped is 10 years.
[h] Note: Tank cars stenciled 112S, 112T, 112J, 114S, 114T, or 114J will have the same retest requirments as 112A or 114A respectively.
"S" indicates car equipped with tank shield and top and bottom shelf couplers.
"J" indicates car equipped with jacketed thermal protection, tank head shield, and top and bottom shelf couplers.
"T" indicates car equipped with spray-on thermal protection, tank head shield, and top and bottom shelf couplers.

SOURCE: General American Transportation Corp., *GATX Tank Car Manual, 4th Edition* (Chicago, IL: 1979), p. 14.

Coincident with the retrofit of certain tank cars and the reduction in serious accidents, FRA also increased the number of over-the-rail inspections of railcars, which may have contributed to reducing the number of rail accidents. There are about 183,000 tank cars, approximately 63 percent of which are used for hazardous materials. FRA performed 39,000 tank car inspections in 1982 and 31,000 in 1983, twice the number of annual inspections (16,000) performed in 1978 and 1979.

The coordination of Federal agencies involved in regulating the rail mode needs improvement. FRA has primary responsibility for regulation, inspection, and enforcement of safety regulations in the rail mode. RSPA has the final say in hazardous materials tank car specifications, although FRA and AAR perform the safety evaluations. RSPA sets regulations for intermodal portable tanks, and keeps track of incidents or spills in the rail mode, while FRA must approve securement for the tanks when they are carried over the rails on flatcars.

A comparison of RSPA's database on hazardous materials incidents with the records of NTSB demonstrated that the inaccurate and incomplete accident records are serious problems for the rail mode.[94] Between 1976 and 1983, 165 accidents involving hazardous materials appeared in the NTSB database that did not appear in the RSPA database. These accidents resulted in 37 deaths, 92 injuries, and $89 million in damages. The value of damages reported to NTSB but not to RSPA exceeded the damages of all rail incidents reported to RSPA over the same time period. Better coordination of Federal activities in data collection could provide a more complete base on which to make regulatory decisions about whether changes in tank car specifications are called for.

The railroads keep detailed records of commodity flows. If this capability were combined with better reporting of releases to RSPA, problems with particular types of tank cars or with particular commodities could be rapidly identified and alleviated. For example, more than 60 percent of all spills are due to loose or defective fittings (chapter 2). This finding indicates a need to reevaluate the specifications for the fittings or the procedures to operate them, or both. Also, OTA contractor data analysis shows that corrosives had the highest release rate in rail transport. Some tank cars that carry corrosive acids (hydrochloric acid, for example) are rubber-lined and are pressure tested only before lining. Additional study is needed to determine whether there is a relationship between test data and release occurrence or whether tank cars carrying corrosives need to be redesigned.

Bulk Water Transport

The largest bulk containers are self-propelled tank ships and tank barges, which together account for about 91 percent of all marine shipping of hazardous materials. Tank barges range in size from 300,000 to 600,000 gallons, and self-propelled tankers can be 10 times larger. About 8 percent of marine shipping of hazardous materials occurs in dry cargo barges, which can carry both bulk (portable tanks) and nonbulk (drums) containers.[95]

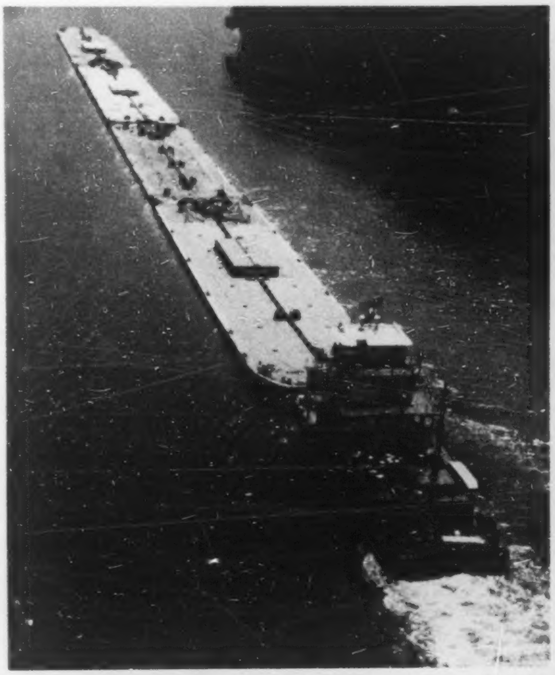

Photo credit: American Waterways Operators

Approximately 35 percent of the hazardous materials tonnage transported in 1982, was by waterborne commerce.

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[94] Abkowitz and List, op. cit.

[95] Abkowitz and List, op. cit.

More than 90 percent of the tonnage in bulk marine transport consists of petroleum products and crude oil. Chemicals constitute about 7 percent, primarily basic chemicals, such as sulfuric acid, fertilizers, sodium hydroxide, alcohols, benzene, and toluene.

Because marine shipments typically involve very large quantities, fewer trips are required to move a given amount of product by water compared to the other modes. Bulk marine shippers and recipients are generally large companies, well aware of the potential liability they assume with each shipment. Because of the substantial economic investment these shipments represent, the companies expend the necessary resources to ensure safe transport as a matter of course. In addition, the vessels travel slowly. For all these reasons, the water mode has the lowest probability of an accident, and is statistically the safest, both in absolute numbers of accidents and spills per ton-mile, although when a spill does occur, the damage can be enormous.

However, other factors also explain why the water mode has the the fewest releases. In the first place, all vessels carrying bulk hazardous materials are subject to Federal hazardous materials regulations. Records kept by the government list every vessel in commerce in U.S. waters and note every shipment of commodities to or from every port in the United States. This recordkeeping emphasizes the accountability of those involved in bulk marine transport.

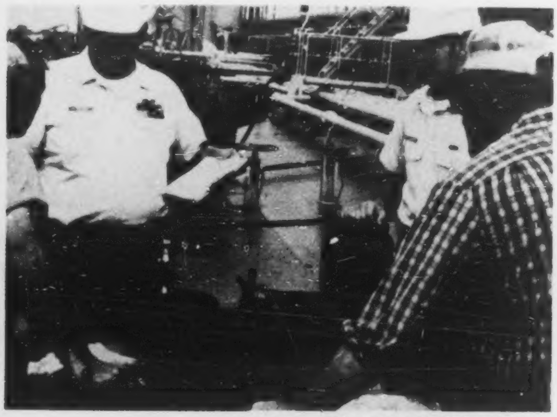

Photo credit: U.S. Coast Guard

Coast Guard personnel examine a vessel carrying hazardous materials.

Moreover, the captains and operators of bulk marine vessels are tested and certified by the U.S. Coast Guard. Regulations require that the self-propelled tank ships and tank barges that carry most of the hazardous materials on water be loaded and unloaded by tankermen who have been tested and endorsed by the Coast Guard. A tankerman must demonstrate familiarity with the general arrangement of cargo tanks, suction, and discharge pipelines and valves, and be able to operate pumps and other equipment connected with the loading and discharging of cargo, as well as fire extinguishing equipment. In addition, the tankerman must demonstrate knowledge of pollution laws and regulations, procedures for discharge containment and cleanup, and methods for disposal of sludge and waste materials from cargo and fueling operations.[96] Because many spills occur during loading and unloading (see chapter 2), shippers generally provide special training to those who load and unload barges and self-propelled tankers.

The Coast Guard also regulates tank barges and self-propelled tank ships. All new vessels to be used for hazardous cargoes in bulk must meet the design requirements of 46 CFR. New vessels must be inspected and certificated by the Coast Guard or by the American Bureau of Shipping. All existing self-propelled tank ships carrying hazardous cargoes must be inspected by the Coast Guard every year. Tank barges are inspected every 2 years, although an additional midterm inspection makes the effective time between inspections just 1 year. Moreover, some major shippers inspect bulk vessels prior to each loading. This frequency-of-inspection requirement may partly explain why the bulk water mode has the best safety record for hazardous materials.

Nonetheless, despite this safety record, bulk water shipments of hazardous materials have been declining; the number of active tank barges in U.S. domestic commerce decreased from 4,900 in 1982 to 4,100 in 1983.[97] One reason is that chemical companies have recently been reducing inventories, partly in response to safety recommendations made after the Bhopal disaster, that smaller volumes of extremely hazardous substances be stored or used in batch processes. In addition, inventory reduction is also one way of making operations more efficient. Storage costs dictate that chemical companies store less and buy only what they will use immediately and that goods be delivered quickly, so production is not interrupted.

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[96] 46 CFR 12.20-5.

[97] The analysis of the changing business practices is based on interviews with representatives of several major chemical and petrochemical companies and on Monsanto Co., *One Year Later: Report of the Monsanto Product and Plant Safety Task Force* (St. Louis, MO: December 1985). The data on numbers of tank barges are from the Waterborne Commerce Statistics Center of the U.S. Army Corp of Engineers.

Intermodal Tank Containers

Intermodal tanks carry 4,000 to 6,000 gallons of liquid in a metal container surrounded by a rigid metal protective frame that facilitates the handling and securing of the tank container in the marine, rail, and highway modes of transport. They are versatile and efficient containers for substances that must travel long distances by several different modes. Used extensively in international trade, they are often carried by rail, water, and truck on a single journey. The capacity of a typical intermodal tank is equivalent to about 100 55-gallon drums, and intermodal tanks are displacing the 55-gallon drum in international commerce when such quantities are transported. In domestic commerce, the tanks are being used for special commodities or on long trips that involve a rail leg, and their use is rapidly increasing in this country as the volume of international trade increases.

For the most part, DOT regulations follow the International Maritime Organization guidelines for tank containers. These tanks are built either to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code or to an equivalent code and must be certified by a DOT approval agency as being designed, manufactured, and tested in compliance with DOT regulations. The three largest approval agencies are the American Bureau of Shipping, Lloyds Register, and Bureau Veritas.

DOT requires a prototype of each tank design series to be performance tested in accordance with the tests required by the International Convention for Safe Containers. The tests simulate the in-service conditions of a tank container in marine, rail, and highway transport. To ensure that tank containers are maintained in good operating condition, DOT requires each tank to be visually inspected at 2½-year intervals and to undergo a hydrostatic pressure test at 1½ times the maximum allowable working pressure every 5 years. The visual test may be conducted by an owner, although when it coincides with a hydrostatic test bath it must be certified by inspectors of the designated approval agencies.[98]

For use in the United States, the tanks must be registered by serial number with DOT, and regulatory responsibility for them and their carrying vehicles is shared by RSPA and the modal administrations. The poor interagency coordination at DOT is a particularly acute problem affecting adequate regulation of the transport of these vessels.

Few appropriate truck chassis for intermodal tank containers are available in the United States. Most of the available chassis are deficient either in length, securement devices, or overall design, which typically incorporates a high center of gravity. Loaded portable tanks must generally be carried on 40-foot chassis in order to comply with bridge laws that limit the vehicle weight per axle and per wheelbase. However, only about 400 40-foot chassis in this country have twist locks that positively secure the portable tank in the center of the chassis, preventing lateral or vertical motion, although there are several thousand portable tanks available for commercial use.[99] Thus, most intermodal tank containers now travel by highway on 40-foot flatbed trucks secured by hooks and chains, legal securement under current regulations, or on 20-foot chassis, which may have proper securement devices, but which violate road weight laws. Industry leaders adamantly maintain that J hooks and chain binders provide grossly inadequate securement for the tanks on flatbed chassis, and accident records are beginning to corroborate this.[100] As recently as November 1985,

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[98] Much of this information is derived from written communication from Donald L. Monroe, American Bureau of Shipping (ABS), Paramus, NJ, April 1986. The ABS is a private not-for-profit, international classification society comprised of shipowners, shipbuilders, naval architects, and others associated with the marine industry, concerned with assuring mechanical and structural fitness of vessels. They establish standards, adopted internationally, by which ships and other marine structures are built and maintained.

[99] George Graham, President, Chemical Leaman Container Corp., agents for Sea Containers Inc., a major owner, leaser, and transporter of intermodal containers, personal communication, October 1985.

[100] George Graham, President, Chemical Leaman Container Corp., agents for Sea Containers, Inc., has strongly advocated that intermodal tanks not be allowed to travel on flatbed trailers secured only by chains. Chain or chain binders allow for tank movement and make the vehicle dangerously unstable. His comments were made at the first semi-annual meeting of the Hazardous Materials Advisory Council, held at Hilton Head Island, SC, Nov. 14, 1985, and reported by Laurie Bradford, in "Inexperience Poses Major Threat to Safety in Transport of 'HM,' " *Traffic World*, Nov. 25, 1985.

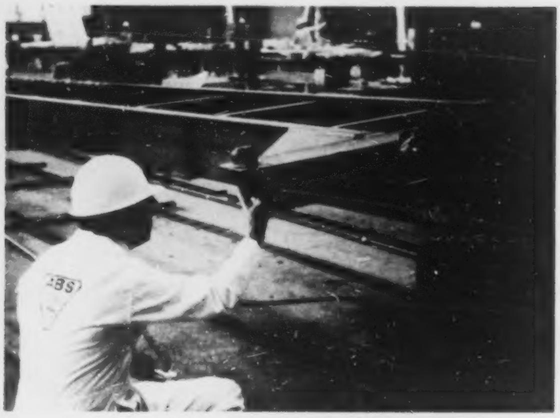

Photo credit: American Bureau of Shipping

American Bureau of Shipping inspector examining the securement device, a "twist lock," on a trailer.

however, DOT officials were claiming that no new regulations were needed for the type of trailer used to transport portable tanks as long as existing securement regulations were followed.[101]

In addition, few chassis are specifically designed for intermodals. A "low boy" chassis with a flatbed several feet lower than normal is ideal for intermodal tank transport. The chassis design keeps the center of gravity low and the vehicle more stable. These chassis are used throughout Europe, but there are fewer than 100 appropriately configured chassis in the United States. Any requirement for increased use of low boy chassis would need to allow time for manufacture of a fleet sufficient for domestic commerce. Moreover, the concentration of the weight of a 20-foot portable tank in the middle of a 40-foot chassis is a new design problem for some manufacturers. Flaws in the design or manufacture of some low boy chassis have caused fractures and failures at the goose neck portion where the support beams descend from the fifth wheel area to the bed of the chassis,[102] and one new chassis failed within 3,000 miles of use.[103]

The behavior of intermodal tanks on trailers is very different from that of regular intermodal containers or even cargo tankers. Intermodal tanks are rarely compartmentalized, so the effects of sloshing liquid cargo can be pronounced when the tank is not full or nearly full. Current regulations require that intermodal tanks be filled to at least 80 percent of their capacity (by volume),[104] close to the level that produces the most unstable conditions in the tank.[105] Not only is the configuration inherently unstable, but the driver often cannot feel the instability until it is too late.[106] For certain commodities, road weight laws may limit the filling of an intermodal tank to 80 percent by volume; thus obeying all the relevant regulations could result in the least stable set of circumstances possible.

Furthermore the use of intermodal tanks in rail traffic is likely to increase, and the safety characteristics of intermodal tanks on trailers on railroad flatcars are not well known. Currently, FRA, which approves securement devices for tanks during travel by rail, is studying the safety characteristics of containers and trailers on rail flatcars. However, appropriate coordination between FRA and the Federal Highway Administration has not been established. FRA is now testing a configuration involving an intermodal tank on a 20-foot truck chassis[107] that is illegal for highway travel in most States, because the weight is not distributed over a long-enough wheelbase to satisfy highway bridge laws. Although the tank and chassis may be within the 80,000 pound gross weight limit, the configuration is either carrying too much weight per axle or for the length of wheelbase. Although FRA is aware that carrying portable tanks on the 20-foot chassis is illegal on most highways, it nonetheless is using the chassis in safety studies.

The Coast Guard monitors the acceptance of portable tanks entering the United States. It also determines whether a tank carrying hazardous materials may be shipped out by vessel and where and how it will be stowed aboard the vessel. Much of the use of intermodal tanks in the marine mode is international.

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[101] Ken Pierson and Alan Roberts, in response to questions at the Hazardous Materials Advisory Council meeting, Hilton Head, SC, November 1985, as reported in *Modern Bulk Transporter*, January 1986.

[102] Donald L. Monroe, Principal Engineer, American Bureau of Shipping, personal communication, April 1986.

[103] George Graham, President, Chemical Leaman Container Corp., personal communication, April 1986.

[104] 49 CFR 173.32c(j).

[105] The most unstable load for steady-state cornering is when the tank is loaded to 75 percent of capacity. R. D. Ervin, et al., University of Michigan Transportation Research Institute, *Liquid Cargo Shifting and the Stability of Cargo Tank Trucks, Final Technical Report*, vol. II (Washington, DC: Federal Highway Administration, Bureau of Motor Carrier Safety, U.S. Department of Transportation, September 1985).

[106] *Hazardous Cargo Bulletin*, "Ullage and Roll Stability," June 1985.

[107] Clair Orth, Federal Railroad Administration (FRA), personal communication, January 1986. FRA is testing an intermodal tank on a 20-foot chassis. Such an arrangement is likely to violate highway bridge laws which specify the gross weight allowed for a given distance between axles.

Ton Tanks.—Certain multiunit cylindrical pressure vessels, commonly called ton tanks because of their characteristic size,[108] are meant to be lifted on and off vehicles for filling and emptying. Specifications for these are published as part of the tank car rules in 49 CFR Part 179. Used chiefly for chlorine transport, these are some of the heaviest and most effective containers in commerce.

Nonbulk Containers

Nonbulk containers are used to transport hazardous materials in all modes but constitute different proportions of traffic in each mode. By tonnage, small packages make up a small proportion of rail and water traffic, about half the highway traffic, and virtually all air traffic. Correspondingly, nonbulk packages constitute a small percentage of the incidents reported in the Hazardous Materials Information System in the rail and water modes, but comprise about 80 percent of the containers cited in highway releases and all the containers cited in air releases.

Materials used in nonbulk packaging include fiberboard, plastic, wood, glass, fiberglass, metal, and combinations of these. Combination packagings or packages within packages are often used in hazardous materials transport and include, for example, glass bottles in fiberboard boxes. Composite packagings are made of two or more materials such as a plastic-lined steel drum. Most containers can be used for a multitude of products, although certain types of packaging are designed for a particular commodity. Free-standing single units such as steel drums and cylinders for compressed gases are also widely used.

Factors related to the realities of the transportation system also influence container design. For example, products that are used only in small unit quantities often are transported packaged in those quantities, and many packagings that will be transported on trucks and railcars are designed to facilitate loading, unloading, and using vehicle space efficiently. The type of handling equipment available is also a consideration. The 55-gallon steel drum, for example, has been called "man-sized" packaging, because it is about the largest unit that can fit through a normal doorway and can be handled by a single person.

Releases from nonbulk packages of hazardous materials, while numerous, generally do not have serious consequences because of the small amounts of materials in the packages. Human error, such as improper packing or handling, rather than poor container design, causes the majority of releases. Moreover, errors such as the use of improper packaging, frequently stem from ignorance, since shippers, especially small companies, find the hazardous materials regulations confusing.

Current packaging regulations are complicated and cumbersome and do not encourage development of packaging innovations. DOT has proposed a rulemaking (Docket No. HM-181) to change the current regulations from design standards specifying how a package must be constructed to performance standards that say what a package must do.* This section of chapter 3 focuses on operational changes affecting safety and on regulatory changes that would simplify and clarify packaging requirements and enable U.S. industry to be more competitive internationally.

Current Design Specifications for Packaging

Although some materials of low hazard do not require "specification packaging" (packages of such materials need only satisfy the general requirements),** DOT specifies detailed packaging requirements for most hazardous materials.

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[108] Specifications 106 and 110.

*Performance standards are described in detail later in this chapter. Rather than stating exactly how and of what materials a package must be constructed, performance standards lay out tests that packages must pass before they can be used. If a package passes the appropriate tests (for example, a 6-foot-drop test or a 4.8 psi pressure test) then it can be used without consideration of the details of its construction. For performance standards to work well, the tests must correlate to the stresses that packages experience in transport.

**For example, dichloromethane, classified as an ORM A material, does not require specification packaging.

As described in a recent DOT advance notice of public rulemaking, a specification typically:

> . . . includes requirements for material, thickness, fastenings, capacity, coatings, openings, joining, carrying devices and miscellaneous other construction requirements. Much of the information is given in great detail and is repetitious. For example, there are fourteen specifications for wooden boxes. Most specifications list the acceptable types of wood from which lumber must be used to construct the box, and this list may be repeated in the next specification for a similar, but slightly different box. In addition to the types of acceptable wood being specified, the thickness and width of the boards, the kind and dimension of nails, and the spacing of the nails in joining the box may also be specified.[109]

While specifications developed over the years have brought a measure of uniformity and familiarity to hazardous materials packaging, they often act as an impediment to new packaging designs. Nevertheless, over the years, new packaging ideas have been developed by container makers and shippers and then discussed with the regulatory agencies.[110] In the era prior to the Hazardous Materials Transportation Act (HMTA), if new packaging appeared to be well designed and to have been successfully tested, regulatory agencies would issue a special permit approving its use by the developers, but would seldom authorize more general use. After the passage of the HMTA in 1975, such authorizations were formalized as exemptions and were controlled and limited. If a shipper wishes to make shipments in a container different from that specified in the regulations, a petition for an exemption must be submitted to DOT. Each exemption is issued for up to 2 years and can be renewed. The exemption holder must report any adverse experiences in addition to any other incident reporting requirements. An ongoing rulemaking (Docket No. HM-139) exists to incorporate successful exemptions into the rules for general applicability.* However, rulemaking is sometimes too slow to keep up with the demand. For example, exemptions covering plastic drums and cryogenic cargo tank specifications were eventually incorporated into the regulations, but only many years after they were first authorized (17 years in the case of the cargo tanks).

Exemptions have become time-consuming administrative problems for both industry and government. RSPA has spent a large portion of staff time processing exemption applications over the years.[111] Staff typically handles about 100 exemptions per month, about half of these dealing with small packages. Exemptions are issued to an original applicant, but other persons can become "parties to" that exemption. Exemptions that have been in effect for several renewal periods and have multiple parties to them are indicators of a deficiency in the rulemaking process. In fact, about 90 percent of all exemptions applications are for renewals or to become parties to existing exemptions.

Performance Standards

In 1969, a conference of transportation experts from government and industry[112] recommended performance standards for packaging. Those experts believed performance standards could eliminate much of the Federal process for granting exemptions, approvals, or specific rulemaking petitions on packaging; eliminate many of the existing voluminous and complex regulations; and open the door to new technologies and innovations in the development of packaging designs. However, not until 1982, did DOT issue an advance notice of proposed rulemaking, Docket No. HM-181, proposing a framework of performance standards governing the design of containers with a capacity of 450 liters (119 gallons) or 400 kilograms (880 pounds) or less.

Effective performance standards require a thorough understanding of the transportation environment to determine precisely how the packaging must perform. Package designers need to know temperature variations, physical stresses during turns and stops, and the nature of shocks and vibrations that their packages are likely to encounter during transport. Once transportation conditions are sufficiently documented, tests can be developed to ensure that the packaging will contain its cargo during transport. Several years ago DOT issued contracts for a study of the transportation environment,[113] which, while not comprehensive, provided useful information on the stresses to which packages are subjected during transportation.

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[109] *Federal Register*, "Performance-Oriented Packagings Standards, HM-181," vol. 47, No. 73, Apr. 15, 1982.

[110] See ch. 4 for a description of the evolution of hazardous materials regulations and the special relationship that industry has had with the regulatory bodies over the years.

*Rulemaking dockets are the procedural means by which new regulations are promulgated. The HM in HM-139 stands for hazardous materials.

[111] U.S. Congress, Congressional Research Service, *Hazardous Materials Transportation: A Review and Analysis of the Department of Transportation Regulatory Program* (Washington, DC: CRS, April 1979), p. 125.

[112] National Research Council, Highway Research Board and the Committee on Hazardous Materials, *A Study of Transportation of Hazardous Materials: A Report to the Office of Hazardous Materials of the U.S. Department of Transportation* (Washington, DC: National Academy Press, 1969).

The performance standards proposed by DOT are based on the United Nations Recommendations for the Safe Transport of Dangerous Goods,[114] which divide hazardous materials into three "Packing Groups" depending on their relative hazards. Packing Group I consists of very dangerous materials, such as fuming sulfuric acid, a Group I corrosive. Packing Group II involves materials presenting a moderate degree of danger, such as hydrochloric acid, also a corrosive. Packing Group III addresses materials presenting only minor danger.

The U.N. Dangerous Goods standards also have general requirements for materials, construction, and maximum size, and specify tests that must be met by packages for each packing class. For example, if it is to carry liquids, the U.N. 1A1 steel drum, one of two types of steel drums in the recommendations, must have welded seams and welded or mechanically seamed chimes (the edges of the drum where the side-wall meets the top and bottom); its opening may not exceed 7 cm in diameter, and the drum may not exceed 450 liters capacity.

Even these requirements may be waived as advances in science and technology occur, as long as the packages are able to withstand performance tests. The strength and integrity of the drums are established by a series of performance tests the drum must pass before it is authorized to carry hazardous materials in each packing group. The principal tests are a drop test, a stacking test, a leak test for containers for liquids, and a hydraulic pressure test. The drop test consists of filling the drum as if for shipment and allowing it to fall to a level, unyielding surface without spilling its contents. The height specified for the drop test is determined by the packing group of the hazardous materials to be transported. The steel drum would have to survive a drop from a height of 1.8 meters (6 feet) if it were to carry a material in Packing Group I, 1.2 meters for Group II, and 0.8 meters for Group III.[115] Thus the most dangerous materials, Packing Group I, must be packaged in the most robust containers.

Adoption of the U.N. recommendations would include not only the U.N. system of packaging, but also the U.N. materials classification, labeling, and shipping descriptions. Unlike the DOT classification system, the U.N. classification system classifies commodities within a given hazard class by degree of hazard, and the placards displaying the hazard class show degree of hazard as well. This aspect is important to emergency response personnel, as these distinctions give an immediate indication of the level of danger during response to an incident.

Some U.S. industry representatives hold that the U.N. standards by themselves will not result in packaging adequate to withstand the rigors of international commerce. They feel that the correlation between the performance tests and the stresses of the transportation environment is not well established and that some minimum design specifications should be retained. For example, a drum manufacturer contends that steel drums intended to contain liquids belonging to Packing Groups I or II should be of 1 mm minimum thickness, equivalent to a thickness of 19 to 20 gauge, to ensure against external puncture.[116]

Moreover, some of the U.N. tests are not as stringent as current DOT specifications. For example, leak test pressures that are part of DOT's current specifications for steel drums are in every case greater than those that would be required under the U.N. system; DOT's requirements range from 7 to 15 pounds per square inch (psi) while the U.N.'s range from 2.8 to 4.3 psi. Some U.S. additions to the tests to address inadequacies in the international standard may be proposed. For example, DOT is expected to require a vibration test as part of the performance standards test program in an effort to model more closely the transportation environment. However, additional testing requirements for packaging used in the United States could become barriers to international trade, a result that the U.N. standards are designed to avoid.

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[113] Fred E. Ostrem and Basil Libovicz, General American Transportation Corp., General American Research Division, *A Survey of Environmental Conditions Incident to the Transportation of Materials Phase II* (Washington, DC: U.S. Department of Transportation, April 1978).

[114] See ch. 4 for a discussion of the U.S. involvement in the development of these recommendations.

[115] Much of this discussion is taken from the Supplementary Information section of HM-181, *Federal Register*, "Performance-Oriented Packaging Standards," op. cit.

[116] William H. Gushard, Grief Brothers Corp., Springfield, NJ, written communication, February 1986.

Because of the uncertainty about the appropriateness of the performance tests in mimicking the transportation environment, it is important to collect data on releases from small packages to permit evaluation of the adequacy of the tests.[117]

Adoption of performance standards would constitute a major change in the way regulations address design of small packaging for hazardous materials transportation. However, DOT and some package manufacturers already have experience with performance standards. For example, the approval process for pressurized cylinders, many steel drums, and many combination packagings of glass bottles inside fiberboard boxes includes performance tests. Comments received by DOT on the proposed performance-oriented packagings standards have generally been favorable, citing the removal of unnecessary impediments to the flow of international commerce, and making the DOT exemption process either unnecessary or at least less cumbersome.

The fate of current U.S. container specifications, once U.N. performance standards are accepted here, is still a subject of debate. Smaller container manufacturers and shippers will probably limit themselves to proven packaging described in the current 49 CFR. DOT has stated that many, if not most, existing DOT packages would successfully pass the performance tests and could continue to be used with U.N. markings.

Moreover, there is little indication that removal of regulatory constraints would bring about significant changes in packaging because the factors leading to a design—such as new products or materials—were never regulatory. Developing a system of performance standards does open the way for greater design flexibility and should smooth the authorization process. Performance standards themselves are unlikely to stimulate greater innovation, although they have the potential for allowing innovations to be implemented more quickly than they are today. Finally, DOT will still be required to consider major innovations and new technologies not addressed in performance standards.

Assessing Small Package Performance

Currently, neither industry (with a few exceptions) nor government appears to monitor systematically the success rate of small packages. An OTA sampling of manufacturers and shippers indicated that customer complaints and package failure reports are the primary means of assessing package performance in the field.

A packaging problem area that may require attention is the compatibility of wastes and their containers. Carriers have unwittingly accepted loads of wastes from shippers unaware of the wastes' composition or properties, and have had corrosion problems in their containers as a result.[118] With many small-quantity generators of hazardous wastes soon becoming subject to Federal regulation under the Resource Conservation and Recovery Act, the potential for mispackaging becomes enormous. These generators will need both information and assistance from EPA and DOT in complying with the new law. (See appendix A.)

Metal drums and glass bottles are the containers that appear most frequently in the incident reports (they were involved in about 2,000 incidents per year from 1976 to 1984 according to RSPA records), but this figure is only a small percentage of the drums and bottles carrying hazardous materials in commerce. However, release rates on either a per-ton-mile or a per-package-shipped basis are nearly impossible to calculate because the commodity flow and release data are poor, especially for the air mode. Without this type of data, RSPA cannot adequately evaluate container design from its release reports. Release rates would yield information on the adequacy of packaging and indicate needs for revised packaging requirements.

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[117] U.S. Department of Transportation (DOT) has published an "Advanced Notice of Proposed Rulemaking" ("Detailed Hazardous Materials Incident Reports," Docket No. HM-36B, *Federal Register*, 10042, Mar. 16, 1984), which would reduce the reporting requirements for incidents involving small packages. If a small package releases hazardous materials, the incident would not need to be reported unless: the material was a hazardous waste, someone was injured or killed, people were evacuated, the package involved was shipped under the Research and Special Programs Administration's exemption program, or property damage including cleanup and decontamination costs exceeded $1,000. While such a rulemaking would relieve carriers of reporting releases with small consequences, it would also deprive DOT of information regarding the safety of particular container types. The cost of a particular release is related more to the contents of the container than its safety. Upon adoption of performance-based standards, it may be prudent to retain the current comprehensive reporting requirements so that the performance tests can be evaluated.

[118] Robert S. Shertz, Chemical Leaman Tank Lines, personal communication, October 1985; and Richard O'Boyle, Quality Carriers Inc., in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop Proceedings on State and Local Activities," op. cit.

Third-Party Testing and Certification for All Packaging

Under U.N. performance standards, the design of a container must be tested and officially certified. Under the U.S. packaging rules in 49 CFR, the marking of the specification number on a container constitutes a certification of compliance with that specification, including any prescribed tests. Testing, marking, and certification are usually done by the maker of the packaging in this country—essentially, self-certification. In Europe, government-owned or specially designated testing laboratories do most of this testing and certification. European road and rail regulatory conventions require U.N. standards in Europe, and U.S. packaging shipped to Europe must comply with those standards, including U.N. marking and certification. Under DOT's proposed performance standard system, container manufacturers would still be able to self-certify their packages. Whether European countries will accept this certification is uncertain, but third-party testing facilities are now available in the United States to certify packages for international trade, should that prove necessary.

In DOT Docket No. HM-194, effective July 1, 1985, DOT established a method for granting government approval to third-party testing facilities. HM-194 spells out various approval requirements for a laboratory, but allows the test facility to determine the precise equipment it needs. As of February 1986, eight such laboratories had been approved by DOT.

Third-party inspection and testing is already required by U.S. regulations for some containers, notably high-pressure compressed gas cylinders and most intermodal portable tanks. For pressure vessels in all modes except rail, construction usually must be completed in accordance with design codes of the American Society of Mechanical Engineers and must be inspected by an authorized third-party inspector. In practice this means that only MC-331 and MC-338 cargo tanks undergo third-party inspection, and there is no third-party role in the construction of most nonpressure tank trucks, the vast majority of cargo tankers. AAR's Mechanical Division is involved in approving tank car construction. Although self-certification is broadly advocated for smaller packaging, third-party testing and certification for larger units is still an open question.

Training in Operations and Procedures

OTA analysis shows that more than 60 percent of hazardous materials releases involving small packages can be attributed to human errors such as improper packing, bracing, loading, or unloading. Vehicle accidents cause another 5 percent of all hazardous materials releases, and human error causes 60 to 70 percent of these accidents.[119] These failings have compromised even well-designed packages, and the greatest opportunity to reduce the frequency of spills may come from programs to address factors other than the containers themselves.

DOT's release reporting system, the Hazardous Materials Information System, cites "struck by other freight," "cargo shifted," "improper loading," and "external puncture" as the reasons for more than 50 percent of small packaging spills. These causes usually occur because shipper or carrier personnel did not properly load, block, and brace packages inside of the vans, railroad cars, and airplane holds in which the small packages travel.

For most transport, the regulations state simply that packages must be secured against movement during normal transportation, although somewhat more specific requirements apply to individual modes or for particular hazard classes. Packages containing explosives have special loading provisions in all the modes, for example. Corrosives must not be loaded above other materials, and compressed gases must be secured in an upright position, or packaged to prevent movement, or placed horizontally on the floor of the vehicle. Other provisions prohibit certain hazard classes from being carried together in the same vehicle or vessel stowage compartment, but generally the regulations do not specify what constitutes appropriate blocking and bracing techniques. Methods of blocking and bracing for the rail mode, recommended by AAR, are referenced in 49 CFR.[120] The high rate of releases associated with loading and unloading activities implies that more explicit procedures might improve safety.

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[119] Washington Utilities and Transportation Commission, op. cit., p. 8.

Analysis of hazardous materials violations also supports a need for shippers to improve operations and procedures. A 1983 informal survey of States participating in a DOT enforcement training program identified the following as the most common hazardous materials violations found during roadside inspections of motor carriers:

- failure to display the correct placard,*
- failure to block or brace hazardous materials containers,
- leaking discharge valves on cargo tanks,
- improperly described hazardous wastes,
- inaccurate or missing shipping papers, and
- excessive radiation levels in the cab of the truck.[121]

In addition, a 1979 report issued by the National Transportation Safety Board cited a number of reasons for noncompliance with the hazardous materials regulations, including:

- the regulations are complex and difficult to understand,
- economic pressures,
- industry personnel often are unaware of the regulations, and
- lack of available training for inexperienced personnel.[122]

Data on both accidental releases and violations of regulations raise questions about the adequacy of private sector training. RSPA's hazardous materials regulations contain only a general statement about training:

> It is the duty of each person who offers hazardous materials for transportation to instruct each of his officers, agents, and employees having any responsibility for preparing hazardous materials for shipment as to the applicable regulations in this subchapter.[123]

However, the complex regulations cover driver qualifications, hazardous materials classification, shipping papers, marking, labeling, and placarding, as well as general operational procedures for loading and unloading, and blocking and bracing of hazardous materials packages.

Good driver performance is especially important for bulk highway transport, where 20 percent of releases are caused by vehicle accidents, most due to driver error. However, RSPA has not specified how drivers are to be instructed in the regulations and has expanded on the general training requirement for the highway transport of only two commodity types: flammable cryogenics and highly radioactive materials. RSPA based the driver training requirement for carriage of flammable cryogenics on the need to increase the driver's knowledge of the hazards of cryogenic liquids, the applicable regulations, and the handling and operating characteristics of the particular vehicle used to transport the material. A certificate indicating completion of training must be on file with the driver's employer.[124]

In addition, drivers hauling highly radioactive materials must receive written training on:

- regulations pertaining to the radioactive materials being transported;
- the properties and hazards of the radioactive materials transported; and
- procedures to be followed in case of an accident or other emergency.[125]

The driver must have in his possession a certificate of training stating that he has received training, the dates of training, and the name and address of the person providing the training.[126] In the final rulemaking notification, RSPA noted the possibility of extending driver training requirements to cover other commodities and of specifying a more structured training program in the future if a need exists.

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[120] The general requirements for loading and unloading, and blocking and bracing are presented in: 49 CFR 174.55 for the rail mode; 49 CFR 175.81 for the air mode; 49 CFR 176.57 and 49 CFR 176.69 for the marine mode; and 49 CFR 177.834 and 49 CFR 177.848 for the highway mode.

*Accurate placards and shipping papers are particularly important for the safety of first responders to hazardous materials emergencies, as they provide essential, basic information on the nature of the materials the responders face.

[121] U.S. Department of Transportation, Research and Special Programs Administration, "Quarterly State Hazardous Materials Enforcement Development (SHMED) Program Progress Reports: 1984-1985," unpublished reports.

[122] National Transportation Safety Board, *Noncompliance With Hazardous Materials Regulations*, NTIS # PB-299 432 (Washington, DC: Aug. 3, 1979), p. 17.

[123] 49 CFR 173.1(b).

[124] *Federal Register*, vol. 48, No. 117, June 16, 1983, p. 27684.

[125] *Federal Register*, vol. 46, No. 12, Jan. 19, 1981, p. 5317.

[126] Ibid., pp. 5298-5318.

Recently BMCS proposed new requirements, similar to those for drivers of flammable cryogenics and large quantity radioactive materials, for drivers of trucks carrying other hazardous materials.[127] However, little guidance is given on how to conduct the training or how long each element of the training might take. Furthermore, no provisions are included for nondrivers who may handle hazardous materials during loading and unloading operations.

Of the DOT modal administrations, only the Federal Aviation Administration has established an explicit training requirement for employees of commercial air carriers. All crewmembers and ground personnel with responsibilities in the acceptance, handling, and carriage of hazardous materials must complete training in an appropriate program established by the carrier.[128] Some air carriers, such as Federal Express and Flying Tigers, also provide training for shippers of hazardous materials.*

The water mode also has training requirements, although they are not specific. Carriers in the water mode must be licensed by the Coast Guard, which tests ship and barge operators to ensure that they are properly trained. In addition, the loading and unloading of tank ships and barges must be done by licensed tankermen who have passed an examination sponsored by the Coast Guard.

Recognizing the factors leading to noncompliance and unsafe procedures, several States have instituted additional training requirements. For example, effective in 1984, Michigan began requiring that intrastate drivers of bulk hazardous materials have 80 hours of training, of which 60 had to be in operation of the vehicle they were to handle. However, in 1985, 21 of 22 Michigan firms failed management audits, because they lacked any record of training, pointing to the necessity for enforcement if training requirements are to be effective.[129] Michigan did not extend training requirements to interstate transporters of bulk hazardous materials because of concerns over preemption of their law by Federal regulations. Several other States have also instituted training requirements.*

Many European countries have also recently implemented definitive training requirements for drivers of transport units carrying tanks or tank containers of hazardous materials. In many cases training courses must be approved by the government or an agency designated by the government. The training must cover:

- general requirements governing the transport of dangerous goods;
- the main types of hazards;
- appropriate prevention and safety measures for the various types of hazards;
- what to do after an accident (first aid, road safety, basic knowledge about the use of protective equipment, etc.);
- labeling and marking to indicate danger;
- what a vehicle driver should and should not do during the carriage of dangerous goods; and
- the purpose and methods of operation of technical equipment on vehicles and the behavior of vehicles carrying tanks or tank containers on the road including the movements (sloshing) of the load.[130]

It is too early to quantify the effect of the training on road safety, but both drivers and safety officials feel it is positive.[131]

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[127] *Federal Register*, "Qualification of Drivers, Notice of Proposed Rulemaking," vol. 51, No. 92, May 13, 1986, pp. 1752-17581.

[128] 14 CFR 135.333. The Federal Aviation Administration (FAA) regulations require training on: proper shipper certification, packaging, marking, labeling, and documentation for hazardous materials; and the compatibility, loading, storage, and handling characteristics of hazardous materials. Commercial air carriers must also maintain records on initial and recurrent training given to crewmembers and ground personnel. FAA has issued an Advisory Circular that provides general guidance to air carriers for training manuals and programs. See U.S. Department of Transportation, Federal Aviation Administration, AC 121-21B, Jan. 3, 1984.

*For example, U.S. Environmental Protection Agency employees from Region IV have attended Federal Express courses to learn how to send environmental samples to laboratories by air.

[129] Sergeant Gary Koss, Michigan Motor Carrier Enforcement Division, Michigan State Police, personal communication, May 1986.

*Massachusetts, Maryland, New Hampshire, Rhode Island, Pennsylvania, California, Georgia, and New Jersey, for example, have training requirements for drivers of vehicles hauling either hazardous materials or, more commonly, hazardous wastes.

[130] United Nations, Economic Commission for Europe, Inland Transport Committee, *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) and Protocol of Signature, Volume III (Annex B)* (New York: 1985), p. 15.

[131] United Nations, Economic Commission for Europe, Inland Transport Committee, *Driver Training Requirements*, GE. 85-21354 (New York: United Nations, Apr. 4, 1985), pp. 2-4.

In the United States, shippers and carriers of hazardous materials and some private firms have developed training programs or courses designed to instruct industry personnel on Federal and State regulations. The recent collective bargaining agreement of the Teamsters Union calls for at least 3 hours of mandatory training of certain workers, including drivers, dock workers, clerical workers, and shop employees, on specified sections of hazardous materials regulations.[132] However, the duration and intensity of the training is left to the discretion of the shipper or carrier.

The American Trucking Association (ATA) provides compliance training through its State organizations and through sale of items such as the publication, *Handling Hazardous Materials,* which describes the hazardous materials regulations in layman's terms, and a five-part slide program that consists of 20-minute modules on specific hazardous materials requirements, such as shipping papers or marking and labeling. The National Tank Truck Carriers, Inc. (NTTC), has produced and sells a slide program and accompanying manual for tank truck drivers on flammable liquids, the most commonly transported hazard class carried by its members. NTTC has nearly completed development of a similar training program on corrosives. Both of these programs were put together by the safety officers of major carriers affiliated with NTTC. Some trucking companies also provide hazardous materials training for their personnel, although small transport companies are generally not able to provide the same level of training as larger firms.[133]

AAR offers training courses for railroad employees, and large railroads instruct transport and yard personnel in hazardous materials regulations and emergency response procedures.* Shippers of tank car quantities of hazardous materials are often large companies that own or lease their tank cars. Such companies frequently have training programs for employees involved with loading and unloading hazardous materials. Recently an interactive videodisk training program covering all aspects of railroad operation, including hazardous materials regulations and handling procedures, was developed by the Port Terminal Rail Authority in Houston, Texas, as a demonstration supported by FRA.[134] Arranged in modules so the trainee can learn at his or her own pace, the training program can be customized for different railroads, and one of the demonstration conditions was that the program be made available to other railroads. Marine shippers generally provide special training to those who load and unload barges and self-propelled tankers.

In addition to the modal trade and professional associations, other private organizations and individual companies offer hazardous materials compliance training. The Chemical Manufacturers Association sponsors training seminars nationwide and on request to industry employees. The Chlorine Institute provides training publications and films on chemical and physical properties of chlorine, appropriate regulations, and handling procedures for normal and emergency operations. Training courses are also available through private consulting firms. However, the courses vary in content and emphasis.

Conclusions and Policy Options

Federal regulations specify the design, physical characteristics, and method of construction for all packages subject to the hazardous materials regulations, and generally, with a few exceptions, the packages perform adequately. However, the correct use of the packagings and the quality of procedures and operations affecting them are equally important to safe transportation. Conclusions and policy options for this section of chapter 3 address regulatory, technical, and procedural issues.

Federal hazardous materials regulations apply to all commerce in all modes with the exception of intrastate commerce by motor carrier.* Release of hazardous materials from trucks owned by a company that operates solely intrastate need not be reported to DOT, and equipment not meeting Federal requirements may be used in some States. Although States are now required to extend enforcement of hazardous materials regulations to intrastate commerce to qualify for Motor Carrier Safety Assistance Program funds, it is not clear how the reporting requirement and container regulations will be handled. **OTA concludes that explicitly extending the reporting requirement and container regulations in 49 CFR to cover intrastate highway commerce would provide important information about container performance, improve safety, and make enforcement and enforcement training more consistent and efficient.** This policy option is also discussed in chapters 2 and 4.

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[132] National Master Freight Safety & Health Committees, 1985-1988 National Master Freight Agreement, *Hazardous Materials Employee Protection/Training Program* (Washington, DC: International Brotherhood of Teamsters, Dec. 19, 1985), pamphlet.

[133] U.S. Congress, Office of Technology Assessment, "Proceedings of Hazardous Materials Packaging Technology Workshop," unpublished typescript, Jan. 24, 1985.

*For example, Union Pacific Systems, Conrail, and Boston & Maine Co. provide hazardous materials compliance training.

[134] Larry Helms, Port Terminal Rail Authority, Houston, TX, personal communication, 1986.

*49 CFR 171.1. Certain materials are covered by Federal regulations even during intrastate commerce. These are hazardous wastes, hazardous substances, and flammable cryogenics.

The highway mode has more shipments and more releases of hazardous materials than the other modes, and more than 20 percent of bulk highway releases are caused by vehicle accidents, most of these due to driver error. The qualifications required for a truck driver's license vary from State to State, although the concept of a national truck driver's license has been endorsed by ATA, insurance industry representatives, and State motor vehicle administrators and enforcement personnel. **OTA concludes that establishing national requirements for a truck driver's license, with a special certification class for hazardous materials that requires over-the-road training in the type of vehicle specified on the license and a good driving record, could greatly improve the safety of the highway mode.** National license requirements and driver training standards could be developed by DOT in cooperation with the States, labor, and industry. However, responsibility for issuing licenses and certifying that the training requirements are met might remain with the States, which could set appropriate fees to cover program costs. The licenses should differentiate between types of vehicles, as varying configurations have different handling characteristics. Special training is important for drivers of tractor-trailers carrying intermodal tanks. If a national drivers license is instituted, special training could be required of carriers of intermodal tanks. Their high center of gravity, concentration of weight in the middle of the chassis, and slosh effects give them unique handling characteristics that demand special training. Ensuring that experienced, safe drivers operate vehicles carrying hazardous materials could reduce the risk to the public significantly.

Analysis of the data on accidental releases of hazardous materials and violations of hazardous materials regulations indicates a need for increased industry training on operating procedures, such as loading, unloading, blocking and bracing, and applicable regulations, particularly for the highway mode. OTA finds that expanded and more specific guidance for shippers and carriers on the content and extent of training courses for carrier personnel is an important priority. Congress might wish to require DOT to establish guidelines for training course content and duration through a consensus process including Federal, shipper, carrier, and freight forwarder expertise to utilize existing resources. Federal encouragement for expanded motor carrier industry compliance education could be accomplished through the Motor Carrier Safety Assistance Program.

Problems with all varieties of cargo tanks have been studied by DOT over the past 10 years. DOT found that many of the releases from cargo tanks come from discharge valves, pressure relief valves, and manhole covers, and that poor maintenance and inspection of the tanks contributed to the spill problem. Many parts of a rulemaking proposed by DOT in September 1985 address these shortcomings. **OTA finds that adoption of the proposed changes calling for higher and more specific manufacturing standards, annual leak testing of all cargo tanks, and stronger manhole covers on gasoline tankers, would improve the safety performance of cargo tanks.** These requirements, would directly address many of the inadequacies uncovered in the DOT studies.

Furthermore, because gasoline cargo tankers are involved in a high percentage of highway deaths and damages due to hazardous materials, Congress may wish to have DOT carefully evaluate more stable designs for this vehicle, the MC-306. The evaluation should take into account both safety and economic considerations. RSPA and the Federal Highway Administration would need to work together effectively to bring about improvements in cargo tank design.

Intermodal portable tank containers are being used in steadily increasing numbers in domestic and international commerce. They present special problems during truck transport, chief among them, the method of securement onto their chassis. Currently, the regulations permit intermodal tanks to travel on flatbed trucks secured by chains, an inexact and frequently unsafe method. **OTA finds that immediate and intensive study of the motor vehicle chassis and securement methods for intermodal portable tanks is urgently needed.** Some chassis built specially for intermodal tanks have twist locks that positively secure the tank against vertical or lateral motion (such chassis are required in Europe). In addition, although currently there are few of them in the United States, the "low boy" chassis with a flatbed several feet lower than normal is ideal, for carrying the tanks, as it keeps the center of gravity low and the vehicle more stable.

Data shows that many releases of hazardous materials arise from failures in the fittings used in sealing the package. In the rail mode, defective or loose fittings were cited as the package failure in more than 60 percent of all spills. Congress could require DOT to continue research into the design of effective closures and fittings on packages.

Because many packages containing hazardous materials are mailed by people with no understanding of the hazardous nature of the materials they are shipping, public education has an important impact on safety. The problem is especially severe in the air transport of small packages, where both mailers and passengers unknowingly violate regulations. An ongoing and widespread public information program on safety and packaging requirements for hazardous materials, directed at both the handlers of small packages and the general public, could reduce the misuse of packagings and improve safety, especially in the air mode. In addition, generators of small amounts of hazardous wastes, who will soon be brought under Federal regulation, will need assistance from DOT and EPA in complying with packaging requirements.

Performance standards for small packages are likely to be adopted within the next few years, and the prospective changeover has been widely supported by most of the affected parties. **OTA finds that the new system will simplify the regulations making compliance with them easier; bring U.S. regulations into greater conformity with those of our international trading partners, and make packaging innovations easier and faster to evaluate and implement.** Adoption of performance standards should reduce the time required of the relatively small RSPA staff to handle exemption applications and free them for other functions such as data and trend analysis, and planning. If the revised regulations allow packages that meet current specifications to be manufactured after performance testing is adopted, small manufacturers and shippers that do not have full design and testing divisions will not be unduly harmed by the new requirements. To ensure that performance tests adequately represent the stresses of the transportation environment, collection of release data for small packages needs to be continued to identify and remedy packaging deficiencies.

Chapter 4

Hazardous Materials Transportation Regulations

Photo credit: Ann Carroll, OTA staff

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Chapter 4

Hazardous Materials Transportation Regulations

The current Federal regulatory system governing the transportation of hazardous materials developed over the past century with substantial industry involvement. Existing U.S. Department of Transportation (DOT) regulations are extensive and consist of detailed engineering specifications for containers, hazard communication requirements such as vehicle placarding, and handling and operating requirements for each mode of transport. Shippers and carriers of hazardous materials must also comply with general safety requirements for vehicles and vessels and with regulations pertaining to specific types of hazardous materials, worker safety, and environmental protection issued by other Federal agencies.

However, regulations contained in Title 49 of the Code of Federal Regulations (49 CFR), are not applied to most intrastate highway shipments. Moreover, international codes, less complex than their U.S. counterparts, are now widely used in the air and water modes. Finally, while many States have adopted 49 CFR wholly or in part, there is great variation among State regulations. Many State and local jurisdictions have enacted laws and regulations where there is an absence of Federal action or where Federal requirements are believed to be insufficient; examples include requirements for permits and registration, licensing of hazardous materials drivers, and notification requirements. Such requirements cause considerable controversy, as industry compliance may require substantial expenditures of time and money. Differing State and local requirements also impede the development of nationally standardized enforcement training. Although the Hazardous Materials Transportation Act (HMTA) contains a provision preempting State and local requirements that are inconsistent with their Federal counterparts, there have been no comprehensive efforts to assess the validity of existing non-Federal laws and regulations.

This chapter is divided into two major sections: the first part describes the development of the Federal role and examines the current regulatory framework; the second covers State and local requirements and questions related to regulatory consistency. For additional information on State and local activities, the reader is referred to OTA's Special Report, *Transportation of Hazardous Materials: State and Local Activities*, March 1986.

THE FEDERAL ROLE

Early History

In 1866, the first Federal law was passed regulating the transportation of hazardous materials, specifically shipments of explosives and flammable materials such as nitroglycerin and glynoin oil.[1] An 1871 statute established criminal sanctions against persons who transported specific hazardous commodities on passenger vessels in U.S. navigable waters in violation of Treasury Department regulations.[2]

Rail shipments of explosives during and after the Civil War were addressed by uncodified statutes and contractual obligations between shippers and carriers based on English common-law principles. Under the common law, common carriers were granted a public charter to operate and were obliged to provide service to anyone upon reasonable request, for reasonable cost, and without unjust discrimination. Carriers could, however, prescribe conditions under which certain freight would be accepted. A shipper was obliged to identify the hazards of a dangerous commodity, use adequate packaging, and provide a clear warning to the carrier of the shipment's hazards.

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[1] Stat. 81, July 3, 1866.

[2] Stat. 441, Feb. 28, 1871. See Historical Note in 46 U.S.C. 170.

The establishment of the Interstate Commerce Commission (ICC) in 1887 marked the beginning of a Federal effort to impose a degree of regulatory uniformity on all modes of transportation.[3] While ICC requirements were first developed for rail transportation, they were eventually extended to other modes. As described below, ICC was the primary regulatory agency with authority over hazardous materials transportation through 1966.

ICC and the Bureau of Explosives

In 1908, Congress passed a law that would govern hazardous materials transportation for more than six decades. The Explosives and Combustibles Act (later called the Explosives and Other Dangerous Articles Act, or EODA) authorized ICC to issue regulations covering the packing, marking, loading, and handling of explosives and other dangerous substances in transit.[4] The statute also prescribed criminal penalties for shippers or carriers who violated ICC regulations. EODA codified many of the contractual obligations that had developed commercially between shippers and rail carriers.

Regulations adopted by ICC in 1911 to implement EODA were based on rail safety standards developed by the Bureau of Explosives, a division of the Association of American Railroads (AAR). Founded in 1905, the Bureau of Explosives developed standards for handling explosives and other dangerous materials by the railroads and assisted with the management of private contracts between shippers and rail carriers to promote development of uniform requirements. EODA amendments enacted by Congress in 1921 authorized ICC to utilize the services of groups such as the Bureau of Explosives in its hazardous materials safety program.[5] Subsequently, ICC delegated extensive rulemaking and enforcement responsibilities to the Bureau.

Under EODA, all hazardous materials transportation activity was barred unless specifically authorized by ICC. As a consequence, ICC regulations were developed on a case-by-case basis in response to specific industry initiatives. Each time a new commodity or container was produced, a special permit had to be approved by ICC. This process is still used, and new permits are now known as exemptions. (For more information, see chapter 3.) Periodically, if ICC had granted a series of requests pertaining to a particular section of the regulations, that section would be revised and streamlined, usually for specific commodities. This pattern has continued, so that today's packaging authorizations are ad hoc and individual in character.

Over the next 40 years, the roles of ICC and the Bureau of Explosives continued to grow as rules originally designed for the railroads were applied to other modes of transport.[6] The U.S. Coast Guard was required to adopt ICC regulations for classification of hazardous materials and for marking, labeling, packing, and certification of portable containers.[7] Regulatory authority over highway transportation was given to ICC in the 1930s. The Civil Aeronautics Board (CAB), in conjunction with safety officials in the U.S. Department of Commerce, developed the first regulations for transportation of hazardous materials by air in the early 1940s. This was also done through wholesale adoption of ICC rules.[8]

ICC relied heavily on the technological expertise of nongovernmental groups for the development of new regulations, because the size and professional knowledge of in-house staff was limited.[9] In 1960, Congress extended ICC's ability to use the services of outside organizations by authorizing the use of carrier and shipper associations in addition to the Bureau of Explosives.[10] As a result of this action, the Tank Car Committee of AAR was given the authority to approve applications submitted to ICC for designs, materials, construction, conversions, or alterations of tank cars.

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[3] The Interstate Commerce Commission was created by the Interstate Commerce Act, 24 Stat. 529, Feb. 4, 1887.

[4] 18 U.S.C. 831-835 (831 has been substantially rewritten, and 832-835 have been repealed).

[5] 41 Stat. 144, Mar. 4, 1921. See 18 U.S.C. 834, Historical and Revision Notes.

[6] In addition to the extension of Interstate Commerce Commission (ICC) rules to other modes of transport, other amendments to the Explosives and Other Dangerous Articles Act passed after 1921 increased the list of hazardous materials addressed by ICC and regulated shippers and common carriers (for rail and highway). See Historical and Revision Notes in 18 U.S.C. Chapter 39.

[7] 46 U.S.C. 170(7)(a). Additional laws were passed that applied to vessels carrying dangerous cargoes, some of which covered international shipments. See, for example, The International Convention for Safety of Life at Sea, 50 Stat. 1121, 1929; Tank Vessel Act of 1936, Chapter 729, 49 Stat. 1889, June 23, 1936; and the Dangerous Cargo Act of 1940, 54 Stat. 1023, Oct. 9, 1940. The influence of international regulations is discussed more fully later in this chapter. The U.S. Coast Guard was established by an act of Congress on Jan. 28, 1915 (14 U.S.C. 1).

[8] The Civil Aeronautics Board (CAB) was created in 1938 by the Civil Aeronautics Act. The purpose of the law was to regulate air carriers and promote the development of safe air commerce. The Federal Aviation Act, Public Law 85-726, Aug. 23, 1958, contained provisions authorizing the assessment of penalties for violations of the hazardous materials regulations and allowing exemptions from existing rules and regulations. See 49 U.S.C. 1472(h) and 1421(c). The Federal Aviation Administration was established by this statute and assumed the noneconomic regulatory functions of CAB. CAB was continued as an economic regulatory agency.

Formation of the Department of Transportation

In 1966, authority to regulate the transportation of hazardous materials was transferred from ICC, the Department of the Treasury, and CAB to a new Federal agency, DOT.[11] Within DOT, separate modal administrations were retained to preserve organizational continuity. Moreover, modal administration functions specified by the act could not be delegated to other Department administrations by the Secretary of Transportation.[12] Thus, although the Secretary had Cabinet-level responsibility for all transportation safety standards (including hazardous materials), each modal administration was allowed to promulgate independent regulations.

Under the new organization, the Federal Aviation Administration (FAA) was responsible for air transportation, the Federal Highway and Railroad Administrations for land, and the Coast Guard for water. Regulations for each mode of transport were published in different parts of the Code of Federal Regulations (CFR). The National Transportation Safety Board (NTSB) was also established to determine and report the cause of transportation accidents and conduct special studies related to safety and accident prevention. A separate entity, the Hazardous Materials Regulations Board, was created by the Secretary of Transportation to coordinate all hazardous materials activities within the Department. The Office of Hazardous Materials, which served as the staff for the Board, proposed revisions to the existing hazardous materials regulatory program.[13] However, each proposed change had to be considered and approved first by the affected modal administrations. Some of the major revisions planned by the Board, such as the development of container performance standards, have still not been implemented by DOT, although a rulemaking for such standards is now in progress.

Legislation pertaining to hazardous materials transportation was passed in 1970 imposing modest requirements on DOT.[14] However, DOT was unable to implement the statute as staff increases requested by the Department were not approved by Congress.[15] The provisions of this law were incorporated into the HMTA of 1975.

The Hazardous Materials Transportation Act of 1975

Persistent administrative and organizational difficulties in the early 1970s led DOT to seek legislation that would consolidate hazardous materials regulatory authority. However, little happened until the crash of a 707 cargo jet hauling several tons of hazardous materials in 1973.[16] The accident inquiry clearly showed a general lack of compliance with existing requirements due to fragmentation of the regulatory authorities, complexity of the regulations, lack of industry familiarity at the working level with Federal regulations, and inadequate government surveillance.[17] These findings echoed the conclusions of studies conducted by the National Research Council, the Comptroller General to Congress, and DOT.[18]

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[9] See U.S. Congress, Senate Committee on Commerce, Science, and Transportation, *Hazardous Materials Transportation* (Washington, DC: U.S. Government Printing Office, 1979), pp. 24-25.

[10] 18 U.S.C. 834(e).

[11] The U.S. Department of Transportation was created by the Department of Transportation Act, Public Law 89-670, 49 U.S.C. 1651. Economic regulatory functions stayed with the Interstate Commerce Commission, the Civil Aeronautics Board, and the Federal Maritime Commission.

[12] The Department of Transportation Act states that: "The functions, powers, and duties specified in this Act to be carried out by each administrator shall not be transferred elsewhere in the Department unless submitted pursuant to provisions of Chapter 9 of Title 5, U.S.C., or by Statute." See 49 U.S.C. 1652(e).

[13] Regulatory revisions proposed by the Hazardous Materials Regulations Board in 1968 addressed the following topics: modal requirements, international consistency, container performance standards, labels for packages, and vehicle placards. In addition, the Board recommended the establishment of a centralized system for data collection, an increase in shipper and manufacturer inspections, and the development of training programs for emergency response personnel. See U.S. Congress, op. cit., pp. 31-32.

[14] The Hazardous Materials Transportation Control Act of 1970, Title III of Public Law 91-458, 49 U.S.C. 1761. The Secretary of Transportation was required to establish facilities and technical staff for evaluating hazards associated with hazardous materials; establish a central reporting system for hazardous materials accidents; conduct a review of all aspects of hazardous materials transportation and recommend appropriate steps to be taken immediately to provide greater control over shipments; and prepare an annual report for Congress on regulatory, enforcement, and exemption activities as well as accident and casualty statistics.

[15] U.S. Congress, op. cit., p. 33.

[16] National Transportation Safety Board, *Aircraft Accident Report*, NTSB-AAR-74-16 (Washington, DC: 1974).

The HMTA was finally passed in 1975.[19] The intent of the law was to improve regulatory and enforcement activities by providing the Secretary of Transportation with broad authority to set regulations applicable to *all* modes of transport. Specifically, the HMTA:

- expanded DOT's potential jurisdiction to any traffic "affecting" interstate commerce (49 U.S.C. 1802);
- authorized the designation of hazardous materials, defined as materials or classes of materials in quantities and forms that the Secretary of Transportation determines may pose an unreasonable risk to health and safety or property (49 U.S.C. 1803);
- authorized DOT to issue regulations related to packing, repacking, handling, labeling, marking, placarding, and routing; and expanded the regulated community to include those who manufacture, test, maintain, and recondition containers or packages used to transport hazardous materials (49 U.S.C. 1804);
- authorized the establishment of a registration program for shippers, carriers, and container manufacturers and reconditioners (49 U.S.C. 1805);
- codified DOT procedures for granting regulatory exemptions (49 U.S.C. 1806);
- provided the Secretary with the ability to conduct surveillance activities (e.g., hold hearings and conduct investigations), establish recordkeeping requirements, and conduct inspections. Provisions of the 1970 Act were also included in this section of the HMTA, such as submission of an annual report to Congress (49 U.S.C. 1808);
- authorized DOT to assess civil and criminal penalties for violations of the HMTA (49 U.S.C. 1809); and
- defined the relationship between the Federal regulations and those of State and local governments, preempting non-Federal rules found to be inconsistent with the Federal program and establishing a procedure whereby DOT could waive preemption (49 U.S.C. 1811).

Shortly after the HMTA was enacted, the Secretary created the Materials Transportation Bureau (MTB) within the Research and Special Programs Administration (RSPA), which was designated the lead DOT agency for hazardous materials regulation.* MTB was delegated responsibility for issuing all hazardous materials transportation regulations except those governing bulk transport by water; these remained with the Coast Guard. However, the modal administrations continued to be responsible for safety regulations, including the development of hazardous materials regulations, applicable to each mode. Inspection and enforcement authority was divided between MTB and the modal administrations.

In 1976, MTB consolidated and amended the hazardous materials regulations based on changes originally proposed in the late 1960s, prior to passage of the HMTA.[20] FAA and part of the Coast Guard regulations, contained in Titles 14 and 46 of CFR, were incorporated into 49 CFR which already contained the highway and rail regulations. Regulations for bulk transport by water remained in 46 CFR. In addition, MTB amended existing requirements for shipping papers, marking, labeling, and placarding, and added new hazard classes. The format of the regulations has essentially remained the same since 1976. Subsequent regulatory amendments, though numerous, have been narrowly focused.

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[17] Ibid., p. 37.

[18] See National Academy of Sciences, National Research Council, *A Study of Transportation of Hazardous Materials* (Washington, DC: National Academy Press, 1969); and U.S. Congress, Senate Committee on Commerce, *Transportation Safety Act of 1974*, Report No. 93-1192 accompanying S. 4057 (Washington, DC: U.S. Government Printing Office, Sept. 30, 1974).

[19] Title I of Public Law 93-633, Jan. 3, 1975, 49 U.S.C 1801. Title II addressed rail safety and Title III made the National Transportation Safety Board an independent agency. The Explosives and Other Dangerous Articles Act was repealed by this statute.

*The Hazardous Materials Board was terminated and the responsibilities of the Office of Hazardous Materials were transferred to the newly formed Materials Transportation Bureau.

[20] See footnote 13. Proposed rules were published on Jan. 24, 1974 (Docket HM-103, 39 F.R. 3164 and Docket HM-112, 39 F.R. 3022). Final rules were published on Apr. 15, 1976, 41 F.R. 15972.

The Current Regulatory Framework

Overview

While RSPA issues most of the hazardous materials regulations under the HMTA, DOT modal administrations, other Federal agencies, private domestic groups, and international organizations significantly influence the movement of hazardous materials in the United States.[21] Table 4-1 indicates the modes of transport addressed by the major regulatory and standard-setting bodies concerned with the transportation of hazardous materials.

The regulatory responsibilities of RSPA and the four modal administrations within DOT are indicated in figure 4-1.[22] Regulations issued by RSPA cover activities of both shippers and carriers of hazardous materials for all four modes of transport (except for bulk shipments by barge or ship, which are governed by Coast Guard regulations) as well as container manufacturers. RSPA also carries out inspection and enforcement activities for multimodal shippers and container manufacturers. RSPA regulations, summarized in table 4-2, are located in 49 CFR. More than 30,000 hazardous materials are subject to these regulations. **Although the HMTA authorized DOT to regulate both interstate and intrastate transportation of hazardous materials by all modes, the regulations have not been applied to most intrastate highway shipments.**[23] Thus, unless State and local governments adopt 49 CFR and specifically apply it to intrastate highway transport, most local shipments of gasoline and other hazardous materials are not subject to Federal regulation.

Table 4-1.—Federal and International Regulatory Framework for Transportation of Hazardous Materials

Type of regulatory or standard-setting body	Highway	Rail	Air	Water
Department of Transportation Administration:				
Research and Special Programs Administration	X	X	X	X
Federal Highway Administration—Bureau of Motor Carrier Safety	X			
Federal Railroad Administration[a]		X		
Federal Aviation Administration			X	
United States Coast Guard[b]				X
Other Federal agencies:				
Environmental Protection Agency	X	X	X	X
Nuclear Regulatory Commission	X	X	X	X
Occupational Safety and Health Administration	X	X	X	X
International organizations:				
United Nations—Committee of Experts on the Transport of Dangerous Goods	X	X	X	X
International Atomic Energy Agency	X	X	X	X
International Civil Aviation Organization			X	
International Air Transport Association			X	
International Maritime Organization				X

[a] The Tank Car Committee of the Association of American Railroads is authorized to approve new tank car designs.

[b] The National Cargo Bureau, Inc., is authorized by the Coast Guard to assist with the administration of international regulations for cargo loading and storage.

SOURCE: Office of Technology Assessment.

Data collection is another activity undertaken by RSPA, other DOT administrations, and other Federal agencies. Chapter 2 describes these activities in more detail, focusing on the limitations of existing efforts to obtain commodity flow and accident information. It is significant from a regulatory perspective that **although the HMTA allows DOT to establish a registration program, current registration requirements are limited to certain groups of shippers, carriers, and container manufacturers**

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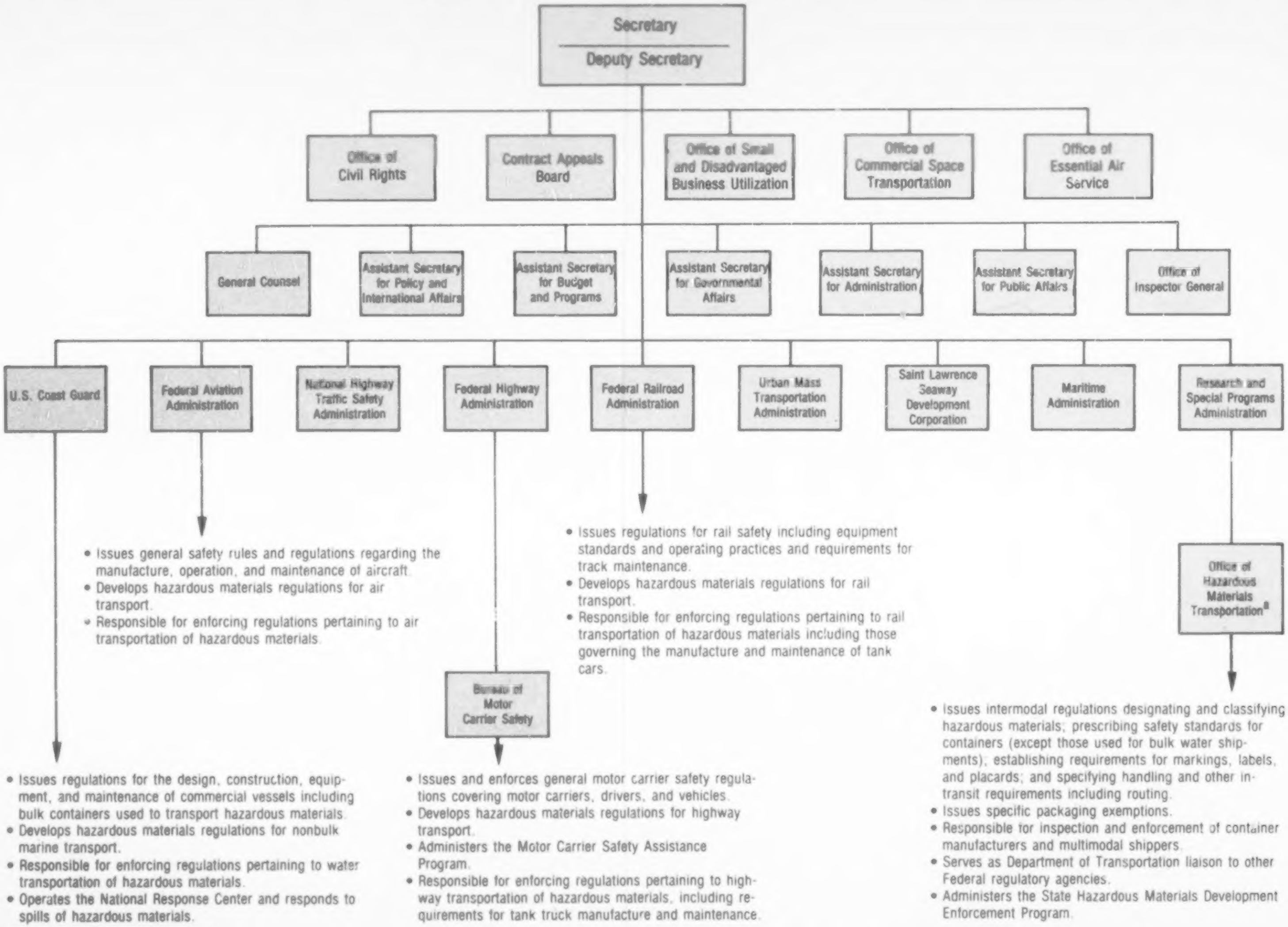
[21] In 1985, the Research and Special Programs Administration (RSPA) was reorganized. The Materials Transportation Bureau was abolished and its responsibilities were transferred to the Office of Pipeline Safety and the Office of Hazardous Materials Transportation within RSPA. RSPA has both rulemaking and enforcement functions pertaining to the transportation of hazardous materials. See 50 F.R. 45728, Nov. 1, 1985.

[22] 49 CFR 1.46, 1.47, 1.48, 1.49, and 1.53 contain delegations of authority for the U.S. Coast Guard, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, and the Research and Special Programs Administration, respectively.

[23] Intrastate shipments of hazardous wastes and substances (designated by the U.S. Environmental Protection Agency) and flammable cryogenic liquids in portable tanks and cargo tanks are covered by Federal regulations. See 49 CFR 171.1.

Figure 4-1.—U.S. Department of Transportation


Secretary
Deputy Secretary
Office of Civil Rights
Contract Appeals Board
Office of Small and Disadvantaged Business Utilization
Office of Commercial Space Transportation
Office of Essential Air Service
General Counsel
Assistant Secretary for Policy and International Affairs
Assistant Secretary for Budget and Programs
Assistant Secretary for Governmental Affairs
Assistant Secretary for Administration
Assistant Secretary for Public Affairs
Office of Inspector General
U.S. Coast Guard
Federal Aviation Administration
National Highway Traffic Safety Administration
Federal Highway Administration
Federal Railroad Administration
Urban Mass Transportation Administration
Saint Lawrence Seaway Development Corporation
Maritime Administration
Research and Special Programs Administration
Bureau of Motor Carrier Safety
Office of Hazardous Materials Transportation[a]

- Issues general safety rules and regulations regarding the manufacture, operation, and maintenance of aircraft.
- Develops hazardous materials regulations for air transport.
- Responsible for enforcing regulations pertaining to air transportation of hazardous materials.

- Issues regulations for rail safety including equipment standards and operating practices and requirements for track maintenance.
- Develops hazardous materials regulations for rail transport.
- Responsible for enforcing regulations pertaining to rail transportation of hazardous materials including those governing the manufacture and maintenance of tank cars.

- Issues regulations for the design, construction, equipment, and maintenance of commercial vessels including bulk containers used to transport hazardous materials.
- Develops hazardous materials regulations for nonbulk marine transport.
- Responsible for enforcing regulations pertaining to water transportation of hazardous materials.
- Operates the National Response Center and responds to spills of hazardous materials.

- Issues and enforces general motor carrier safety regulations covering motor carriers, drivers, and vehicles.
- Develops hazardous materials regulations for highway transport.
- Administers the Motor Carrier Safety Assistance Program.
- Responsible for enforcing regulations pertaining to highway transportation of hazardous materials, including requirements for tank truck manufacture and maintenance.

- Issues intermodal regulations designating and classifying hazardous materials; prescribing safety standards for containers (except those used for bulk water shipments); establishing requirements for markings, labels, and placards; and specifying handling and other in-transit requirements including routing.
- Issues specific packaging exemptions.
- Responsible for inspection and enforcement of container manufacturers and multimodal shippers.
- Serves as Department of Transportation liaison to other Federal regulatory agencies.
- Administers the State Hazardous Materials Development Enforcement Program.

[a] Formerly the Materials Transportation Bureau.

SOURCE: Office of Technology Assessment.

and reconditioners.[24] A more comprehensive registration program would provide DOT with basic data on the industry it regulates.

The modal administrations are also responsible for developing and enforcing hazardous materials regulations applicable to each mode. In addition, they have jurisdiction over general safety regulations for operations, vehicles, and vessels under other Federal statutes.[25] Despite monthly intermodal meetings, there is little coordination among the DOT agencies.

Two other Federal agencies, the U.S. Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC), establish transportation-related requirements for hazardous substances and wastes and radioactive materials. The Occupational Safety and Health Administration (OSHA) is responsible for the safety of workers employed by shippers and carriers of hazardous materials. While the regulatory role of ICC has been diminished, carriers are required to publish rates and obtain operating certificates. The Department of Defense (DOD) and the Department of Energy (DOE), as major shippers and carriers of hazardous materials, have also established some additional transportation requirements for their own shipments. In addition, packages containing hazardous materials sent by mail must comply with DOT and U.S. Postal Service regulations; chapter 5 describes training available for Postal Service employees.

Table 4-2.—Summary of U.S. Department of Transportation Hazardous Materials Regulations in Title 49 of the Code of Federal Regulations

Part 106 prescribes general rulemaking procedures for adopting Office of Hazardous Materials Transportation regulations.[a]

Part 107 contains procedures for the submission and review of packaging exemption applications, inconsistency rulings, and nonpreemption determinations. Enforcement authorities are also described.

Part 171 is a general introduction to the hazardous materials regulations. Special requirements for hazardous wastes are included, as well as definitions of terms and a list of technical documents incorporated by reference into the regulations. Reporting requirements for hazardous materials accidents are also specified.

Part 172 contains the Hazardous Materials Table. The table lists the hazardous materials and hazard classes subject to regulation; appropriate requirements for labels, packaging, and air and water shipments are referenced. In addition, Part 172 includes detailed regulations for shipping papers, markings, labels, and placards.

Part 173 indicates the types of packagings that may be used by shippers of hazardous materials. General shipment and packaging regulations are followed by more specific requirements for certain hazard classes. Hazard class definitions are also contained in Part 173.

Part 174 prescribes regulations for rail transport. General operating, handling, and loading requirements are specified, as well as detailed requirements for certain hazard classes.

Part 175 applies to passenger and cargo aircraft shipments of hazardous materials. The regulations include quantity limitations, loading and handling requirements, and special requirements for certain hazard classes.

Part 176 addresses nonbulk transportation of hazardous materials by waterborne vessels. Requirements for accepting freight, handling, loading, and stowage are prescribed. Coast Guard regulations for bulk shipments of hazardous materials are contained in Title 46 of the *Code of Federal Regulations*.

Part 177 contains regulations for the highway mode; they apply to common, contract, and private carriers. In addition to regulations for handling, loading, and stowage, routing rules for high-level radioactive materials and other in-transit requirements are specified.

Part 178 presents detailed specifications for the fabrication and testing of packagings described in Part 173.

Part 179 prescribes detailed specifications for rail tank cars. Procedures for obtaining Association of American Railroads approval of new tank car designs or changes to existing ones are provided.

[a]The Office of Hazardous Materials Transportation was formerly the Materials Transportation Bureau.

SOURCE: Office of Technology Assessment.

RSPA serves as the DOT liaison with other Federal agencies for hazardous materials. Memoranda of Understanding have been signed with EPA, NRC, and DOE delegating responsibilities under specific laws. One Federal coordinating group does exist, the National Response Team (NRT), but it is concerned primarily with emergency response activities. Aside from these agreements and NRT, however, there are no formal mechanisms for interagency coordination of regulatory matters. While the division of responsibilities among multiple Federal agencies means that modal safety concerns and questions relating to radioactive or hazardous waste materials are addressed by those with appropriate expertise, it also means that when issues arise that require the attention of more than one agency, a method of ensuring effective coordination does not exist. Interagency regulatory issues generally take years to resolve, and the range of options considered by one agency to address a problem is often limited because actions involving others are not studied. Chapters 2, 3, and 5 illustrate some interagency coordination problems that exist.

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[24] The following are examples of registration requirements that have been established by the U.S. Department of Transportation (DOT): shippers and carriers of flammable cryogenic liquids must comply with registration and driver training requirements (see 49 CFR 173.11, 177.816, and 177.826); reconditioners of steel drums (DOT specifications 17C, 17E, and 17H) must obtain registration numbers from DOT and mark drums qualified for reuse with such numbers (see 49 CFR 173.28(m)(3)(ii)); manufacturers of DOT specification containers must register a symbol with DOT if their full names are not provided on containers (see "marking sections" for each specification in 49 CFR 178); independent inspection agencies who wish to perform cylinder inspections and verifications must obtain DOT approval (see 49 CFR 300(a)); and shippers of highway route controlled quantities of radioactive materials, such as spent fuel, must file specified information with DOT within 90 days after a package is accepted by a carrier (see 49 CFR 173.22(d)).

[25] For example, Bureau of Motor Carrier Safety activities are authorized by the Motor Carrier Safety Act of 1980 (Public Law 96-296), the Surface Transportation Act of 1982 (Public Law 97-424), and the Motor Carrier Assistance Act of 1984 (Public Law 98-554). Federal Railroad Administration activities are authorized by the Federal Railroad Safety Act of 1970, as amended (45 U.S.C. 431 et seq.). Federal Aviation Administration activities are authorized by the Federal Aviation Act of 1958 (72 Stat. 744).

Private domestic organizations continue to play an influential role in the development and implementation of regulations governing the transportation of hazardous materials. Such reliance on industry for technical input is inevitable in light of RSPA's small staff and budget restrictions. For example, staff levels have decreased from 143 positions in 1979 to 111 in 1985.[26] These decreases have occurred despite increasing regulatory demands on RSPA staff and rising public concerns about safety.

Other organizations, like AAR, develop standards and testing requirements, conduct inspections, and provide their members with information on existing and proposed regulations.[27] Moreover, a number of international regulatory bodies have established recommendations and standards affecting all modes of transport. At an accelerating pace, international regulations governing the transportation of hazardous materials are being used instead of DOT regulations. This is particularly true for the air and water modes where international requirements that must be followed for overseas shipments are recognized by DOT for domestic use.

State and local governments also regulate matters that can be classified as accident prevention and protection of public safety, such as routing, permits, or licenses. Requirements set by States and localities focus primarily on highway and rail transport and often vary from those established by the Federal Government and other jurisdictions. Interjurisdictional issues are addressed later in this chapter.

The following sections describe existing hazardous materials regulations relevant to all four modes (intermodal) and those applicable only to the highway, rail, air, or water mode. Each section also discusses the private domestic and international organizations active in the regulatory process. The responsibilities of other Federal agencies are presented in a separate section at the end of the chapter. Enforcement activities and training are discussed in chapter 5.

Intermodal

Regulations applicable to all modes of transport consist of two basic types of requirements set by RSPA: use of authorized packaging to ensure effective containment during transport; and clear communication of the hazards of the cargo through shipping papers, markings, labels, and vehicle placards. Shippers begin the regulatory process by identifying the hazards of their cargo.

Classification of Hazardous Materials.—Hazardous materials subject to RSPA regulations are listed in the Hazardous Materials Table in Part 172.101 of 49 CFR. A sample page of the table is shown in table 4-3. The Hazardous Materials Table indicates the hazard class to which each material belongs and references the packaging, labeling, and special requirements applicable to rail, air, and water transportation that must be met by shippers and carriers. The hazard classes designated by RSPA are defined in table 4-4.

In those instances where a material is not listed in the Hazardous Materials Table, the shipper must evaluate it against the criteria for all of the hazard classes. However, the regulations contain no explicit

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[26] Staff levels are for both hazardous materials transportation and pipeline safety offices. There have not been any significant trends in the U.S. Department of Transportation's budget. Funding appropriated by Congress in 1985 was $6.114 million. Data provided by the Research and Special Programs Administration, Apr. 15, 1986.

[27] Various organizations publish general standards for hazardous materials that are applied to the transportation field. These groups include the American Society of Mechanical Engineers, the American Society for Testing and Materials, the Compressed Gas Association, the Institute of Makers of Explosives, the National Association of Corrosion Engineers, and the National Fire Protection Association. 49 CFR 171.7 indicates the organizations and standards incorporated into the hazardous materials regulations by the U.S. Department of Transportation.

Table 4-3.—Sample Page From the Hazardous Materials Table

(1)	(2)	(3)	(3A)	(4)	(5) Packaging		(6) Maximum net quantity in one package		(7) Water shipments		
+/E/A/W	Hazardous materials descriptions and proper shipping names	Hazard class	Identification number	Label(s) required (if not excepted)	(a) Exceptions	(b) Specific requirements	(a) Passenger carrying aircraft or railcar	(b) Cargo aircraft only	(a) Cargo vessel	(b) Passenger vessel	(c) Other requirements
	Acetyl cyclohexanesulfonyl peroxide, more than 82%, wetted with less than 12% water	Forbidden									
	Acetyl cyclohexanesulphonyl peroxide, *not more than 82%, wetted with not less than 12% water. See* Organic peroxide, solid, n.o.s.		UN2082								
	Acetyl cyclohexanesulphonyl peroxide, *not more than 32% in solution. See* Organic peroxide, liquid *or* solution, *n.o.s.*		UN2083								
	Acetylene	Flammable gas	UN1001	Flammable gas	None	173.303	Forbidden	300 pounds	1	1	Shade from radiant heat
	Acetylene (liquid)	Forbidden									
	Acetylene silver nitrate	Forbidden									
A	Acetylene tetrabromide	ORM-A	UN2504	None	173.505	173.510	10 gallons	55 gallons			
	Acetyl iodide	Corrosive material	UN1898	Corrosive	173.244	173.247	1 quart	1 gallon	1	1	Keep dry. Glass carboys not permitted on passenger vessels
	Acetyl peroxide, *not more than 25% in solution. See* Acetyl peroxide solution, *not over 25% peroxide*		UN2084								
	Acetyl peroxide, solid, or more than 25% in solution	Forbidden									
	Acetyl peroxide solution, *not over 25% peroxide*	Organic peroxide	UN2084	Organic peroxide	173.153	173.222	Forbidden	1 quart	1,2	1	
	Acid butyl phosphate	Corrosive material	UN1718	Corrosive	173.244	173.245	1 quart	5 gallons	1,2	1,2	Glass carboys in hampers not permitted under deck
	Acid carboy, empty. *See* Carboy, empty										
	Acid, liquid, n.o.s.	Corrosive material	NA1760	Corrosive	173.244	173.245	1 quart	5 pints	1	4	Keep cool
+E	Acrolein, inhibited *(RQ-1/.454)*	Flammable liquid	UN1092	Flammable liquid and Poison	None	173.122	Forbidden	1 quart	1,2	5	Keep cool. Stow away from living quarters
	Acrylic acid	Corrosive material	UN2218	Corrosive	173.244	173.245	1 quart	5 pints	1	1	
E	Acrylonitrile *(RQ-100/45.4)*	Flammable liquid	UN1093	Flammable liquid and Poison	None	173.119	Forbidden	1 quart	1,2	5	Keep cool
	Actuating cartridge, explosive *(fire extinguisher or valve)*	Class C explosive		Explosive C	173.114		50 pounds	150 pounds	1,2	1,2	Keep cool and dry
	Adhesive	Combustible liquid	UN1133	None	173.118a	None	No limit	No limit	1,2	1,2	
	Adhesive	Flammable liquid	UN1133	Flammable liquid	173.118	173.132	1 quart	10 gallons	1,2	1	
E	Adipic acid *(RQ-5000/2270)*	ORM-E	NA9077	None	None	173.510	No limit	No limit	1,2	1,2	
	Aerosol product. See Compressed gas, n.o.s.										
	Air, compressed	Nonflammable gas	UN1002	Nonflammable gas	173.306	173.302	150 pounds	300 pounds	1,2	1,2	
	Air conditioning machine. *See* Refrigerating machine										
	Aircraft rocket engine *(Commercial)*	Flammable solid	NA2701	Flammable solid	None	173.238	Forbidden	550 pounds	1,3	5	
	Aircraft rocket engine igniter *(Commercial)*	Flammable solid	UN2702	Flammable solid	None	173.238	Forbidden	25 pounds	1,3	5	
	Airplane flare. See Fireworks, special										
	Alcoholic beverage	Flammable liquid	UN1170	Flammable liquid	173.118	173.125	See 173.118(c)	10 gallons	1,2	1	
	Alcoholic beverage	Combustible liquid	UN1170	None	173.118a	None	No limit	No limit	1,2	1,2	
	Alcohol, n.o.s.	Flammable liquid	UN1987	Flammable liquid	173.118	173.125	1 quart	10 gallons	1,2	1	
	Alcohol, n.o.s.	Combustible liquid	UN1987	None	173.118a	None	No limit	No limit	1,2	1,2	
E	Aldrin *(RQ-1/0.454)*	Poison B	NA2761	Poison	173.364	173.376	50 pounds	200 pounds	1,2	1,2	
EA	Aldrin, cast solid *(RQ-1/0.454)*	ORM-A	NA2761	None	173.505	173.510	No limit	No limit	1,2	1,2	
E	Aldrin mixture, dry *(with more than 65% aldrin) (RQ-1/0.454)*	Poison B	NA2761	Poison	173.364	173.376	50 pounds	200 pounds	1,2	1,2	
EA	Aldrin mixture, dry, with 65% or less aldrin *(RQ-1/0.454)*	ORM-A	NA2761	None	173.505	173.510	No limit	No limit	1,2	1,2	
E	Aldrin mixture, liquid *(with more than 60% aldrin) (RQ-1/0.454)*	Poison B	NA2762	Poison	173.345	173.361	1 quart	55 gallons	1,2	1,2	If flash point less than 141 deg F, segregation same as for flammable liquids
EA	Aldrin mixture, liquid, with 60% or less aldrin *(RQ-1/0.454)*	ORM-A	NA2762	None	173.505	173.510	No limit	No limit	1,2	1,2	
	Alkaline *(corrosive)* liquid, n.o.s.	Corrosive material	NA1719	Corrosive	173.244	173.249	1 quart	5 gallons	1,2	1,2	
	Alkanesulfonic acid	Corrosive material	UN2584	Corrosive	173.244	173.245	5 pints	1 gallon	1,2	1	
	Alkyl aluminum halides. See Pyrophoric liquid, n.o.s.										
A	Allethrin	ORM-A	NA2902	None	173.505	173.510	No limit	No limit			
E	Allyl alcohol *(RQ-100/45.4)*	Flammable liquid	UN1098	Flammable liquid and Poison	None	173.119	1 quart	10 gallons	1,2	1	
	Allyl bromide	Flammable liquid	UN1099	Flammable liquid	173.118	173.119	Forbidden	10 gallons	1,2	1	
E	Allyl chloride *(RQ-1000/454)*	Flammable liquid	UN1100	Flammable liquid	None	173.119	Forbidden	10 gallons	1,3	5	
	Allyl chlorocarbonate	Flammable liquid	UN1722	Flammable liquid	None	173.288	Forbidden	5 pints	1	5	Keep dry. Separate longitudinally by an intervening complete hold or compartment from explosives. Segregation same as for corrosive materials
	Allyl chloroformate. *See* Allyl chlorocarbonate										
	Allyl trichlorosilane	Corrosive material	UN1724	Corrosive	None	173.280	Forbidden	10 gallons	1	1	Keep dry
	Aluminum alkyl. *See* Pyrophoric liquid, n.o.s.										

SOURCE: 49 *CFR* 172.101.

Table 4-4.—Department of Transportation Hazard Classes

Hazard class	Definition	Examples
Flammable liquid	Any liquid having a flash point below 100° F as determined by tests listed in 49 CFR 173.115(d). Exceptions are listed in 49 CFR 173.115(a).	Ethyl alcohol, gasoline, acetone, benzene, dimethyl sulfide.
Combustible liquid	Any liquid having a flash point at or above 100° and below 200° F as determined by tests listed in 49 CFR 173.115(d). Exceptions are listed in 49 CFR 173.115(b).	Ink, methyl amyl ketone, fuel oil
Flammable solid	Any solid material, other than an explosive, liable to cause fires through friction or retained heat from manufacturing or processing, or which can be ignited readily creating a serious transportation hazard because it burns vigorously and persistently (49 CFR 173.150).	Nitrocellulose (film), phosphorus, charcoal
Oxidizer	A substance such as chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter (49 CFR 173.151).	Potassium bromate, hydrogen peroxide solution, chromic acid
Organic peroxide	An organic compound containing the bivalent -O-O- structure and which may be considered a derivative of hydrogen peroxide where one or more of the hydrogen atoms have been replaced by organic radicals. Exceptions are listed in 49 CFR 173.151(a).	Urea peroxide, benzoyl peroxide
Corrosive	Liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact. Liquids that severely corrode steel are included (49 CFR 173.240(a)).	Bromine, soda lime, hydrochloric acid, sodium hydroxide solution
Flammable gas	A compressed gas, as defined in 49 CFR 173.300(a), that meets certain flammability requirements (49 CFR 173.300(b)).	Butadiene, engine starting fluid, hydrogen, liquefied petroleum gas
Nonflammable gas	A compressed gas other than a flammable gas.	Chlorine, xenon, neon, anhydrous ammonia
Irritating material	A liquid or solid substance which on contact with fire or when exposed to air gives off dangerous or intensely irritating fumes. Poison A materials excluded (49 CFR 173.381).	Tear gas, monochloroacetone
Poison A	Extremely dangerous poison gases or liquids belong to this class. Very small amounts of these gases or vapors of these liquids, mixed with air, are dangerous to life (49 CFR 173.326).	Hydrocyanic acid, bromoacetone, nitric oxide, phosgene
Poison B	Substances, liquids, or solids (including pastes and semi-solids), other than Poison A or irritating materials, that are known to be toxic to humans. In the absence of adequate data on human toxicity, materials are presumed to be toxic to humans if they are toxic to laboratory animals exposed under specified conditions (49 CFR 173.343).	Phenol, nitroaniline, parathion, cyanide, mercury-based pesticides, disinfectants
Etiologic agents	A viable micro-organism, or its toxin, which causes or may cause human disease. These materials are limited to agents listed by the Department of Health and Human Services (49 CFR 173.386, 42 CFR 72.3).	Vibrio cholerae, clostridium botulinum, polio virus, salmonella, all serotypes
Radioactive material	A material that spontaneously emits ionizing radiation having a specific activity greater than 0.002 microcuries per gram (μCi/g). Further classifications are made within this category according to levels of radioactivity (49 CFR 173, subpart I).	Thorium nitrate, uranium hexafluoride
Explosive	Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, unless such compound, mixture, or device is otherwise classified (49 CFR 173.50). Explosives are divided into three subclasses:	
	Class A explosives are detonating explosives (49 CFR 173.53);	Jet thrust unit, explosive booster
	Class B explosives generally function by rapid combustion rather than detonation (49 CFR 173.88); and	Torpedo, propellant explosive
	Class C explosives are manufactured articles, such as small arms ammunition, that contain restricted quantities of Class A and/or Class B explosives, and certain types of fireworks (49 CFR 173.100).	Toy caps, trick matches, signal flare, fireworks
Blasting agent	A material designed for blasting, but so insensitive that there is very little probability of ignition during transport (49 CFR 173.114(a)).	Blasting cap

Table 4-4.—Department of Transportation Hazard Classes—Continued

Hazard class	Definition	Examples
ORM (Other Regulated Materials)	Any material that does not meet the definition of the other hazard classes. ORMs are divided into five substances:	
	ORM-A is a material which has an anesthetic, irritating, noxious, toxic, or other similar property and can cause extreme annoyance or discomfort to passengers and crew in the event of leakage during transportation (49 CFR 173.500(a)(1)).	Trichloroethylene, carbon tetrachloride, ethylene dibromide, chloroform
	ORM-B is a material capable of causing significant damage to a transport vehicle or vessel if leaked. This class includes materials that may be corrosive to aluminum (49 CFR 173.500(a)(2)).	Calcium oxide, ferric chloride, potassium fluoride
	ORM-C is a material which has other inherent characteristics not described as an ORM-A or ORM-B, but which make it unsuitable for shipment unless properly identified and prepared for transportation. Each ORM-C material is specifically named in the Hazardous Materials Table in 49 CFR 172.101 (49 CFR 173.500(a)(3)).	Castor beans, cotton, inflatable life rafts
	ORM-D is a material such as a consumer commodity which, although otherwise subject to regulation, presents a limited hazard during transportation due to its form, quantity, and packaging (49 CFR 173.500(a)(4)).	Consumer commodity not otherwise specified, such as nail polish; small arms ammunition
	ORM-E is a material that is not included in any other hazard class, but is subject to the requirements of this subchapter. Materials in this class include hazardous wastes and hazardous substances (49 CFR 173.500(a)(5)).	Kepone, lead iodide, heptachlor, polychlorinated biphenyls

SOURCE: 49 *CFR* 172.101 and 173.

guidance for shippers on how to classify a hazardous material. The criteria set by DOT for these hazard classes vary; some are based entirely on a quantifiable test, such as flash point determinations for flammable liquids, while others require shippers to exercise their judgment, as for the flammable solid definition. If a material falls into more than one hazard class, a shipper must follow a specified hierarchy of hazards based on the quality of packaging associated with each hazard class.[28]

Many of the hazard classes currently in use were initially established by ICC decades before the HMTA was passed. These early regulations focused on materials likely to cause immediate injury to carrier personnel and the public if they were unexpectedly released during transport.[29] DOT did not expand the list of hazard classes covered by the regulations until the early 1970s.

Corrosive solids were added to the list of hazard classes in 1974, and when DOT consolidated the hazardous materials regulations in 1976, a new classification, "Other Regulated Materials" (ORM), was created. The ORM hazard class consisted of four subclasses, ORM-A, B, C, and D, and was introduced by DOT to include materials that were encompassed by the hazard classifications used by FAA and the Coast Guard prior to consolidation of the regulations.[30]

In 1980, DOT added a fifth ORM class, ORM-E, to include hazardous substances and wastes regulated by EPA that did not fit into one of the existing DOT hazard classes. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a statute primarily concerned with responses to releases of hazardous substances into the environment, required DOT to expand its list of hazardous materials to include hazardous substances and wastes designated under other environmental laws.[31] While DOT has listed these substances in the CFR, transportation regulations for shippers and carriers are presently applicable only to hazardous wastes under the Resource Conservation and Recovery Act and hazardous substances under the Federal Water Pollution Control Act, not the entire list of substances defined under CERCLA.[32]

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[28] 49 CFR 173.2.

[29] The Explosive and Other Dangerous Articles Act made explicit reference to explosives and other dangerous articles such as radioactive materials, etiologic agents, flammable liquids and solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances. See 18 U.S.C. 834(e).

[30] ORM-A materials are those with the potential to impair the respiratory and visual functions of aircraft crew members in the event of a spill. ORM-B materials are those corrosive to aluminum, another concern in air transport. ORM-C consists of materials that were regulated by the U.S. Coast Guard as "Hazardous Articles" including those with the potential to heat spontaneously if kept in a closed, damp environment for an extended period of time. Finally, ORM-D materials are consumer commodities, such as charcoal or nail polish, which present limited hazards during transport because of their form, quantity, or packaging. See 41 F.R. 15972, Apr. 15, 1976.

Underlying DOT's current classification system are several assumptions—that most accidents involve fire, that only acute health effects need to be considered, and that only people close to the scene of an accident will be affected. The National Transportation Safety Board and others have asserted that these considerations are insufficient and that DOT's classification system does not adequately indicate degrees of hazard and does not take into account all of the potential dangers posed by a hazardous materials accident.[33] For example, releases that do not involve fires may be just as dangerous as those that do and can affect people miles from the scene. Furthermore, long-term health effects and the potential for environmental damage, such as groundwater contamination, as well as the difficulty in cleaning up released materials, should also be considered in the identification and classification of hazardous materials. Chapter 3 discusses the classification issue in the context of packaging requirements for hazardous materials.

Hazard Communication.—The regulations require shippers and carriers to communicate the hazards of their cargo by providing shipping papers, markings, labels, and placards. These requirements are important because they are intended to furnish essential information about the cargo to emergency response personnel if accidents occur.

Shipping Papers.—Most shipments of hazardous materials must be accompanied by shipping papers that describe the hazardous material and contain a certification by the shipper that the material is offered for transport in accordance with applicable DOT regulations.[34] For most shipments, DOT does not specify the use of a particular document and the information can be provided on a bill of lading, waybill, or similar document. Figure 4-2 is a sample shipping document. The exceptions are hazardous waste shipments, which must be accompanied by a specific document called the Hazardous Waste Manifest. A manifest lists EPA identification numbers of the shipper, carrier, and the designated treatment, storage, or disposal facility, in addition to the standard information required by DOT.[35]

Instructions for describing hazardous materials are provided in the regulations. These descriptions include the quantity of the material, its shipping name (taken from the Hazardous Materials Table in 49 CFR 172) and hazard class, and the United Nations/North America (UN/NA) hazard identifi-

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[31] These statutes include the Federal Water Pollution Control Act, the Resource Conservation and Recovery Act, the Clean Air Act, and the Toxic Substances Control Act. See Section 306 (b) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601).

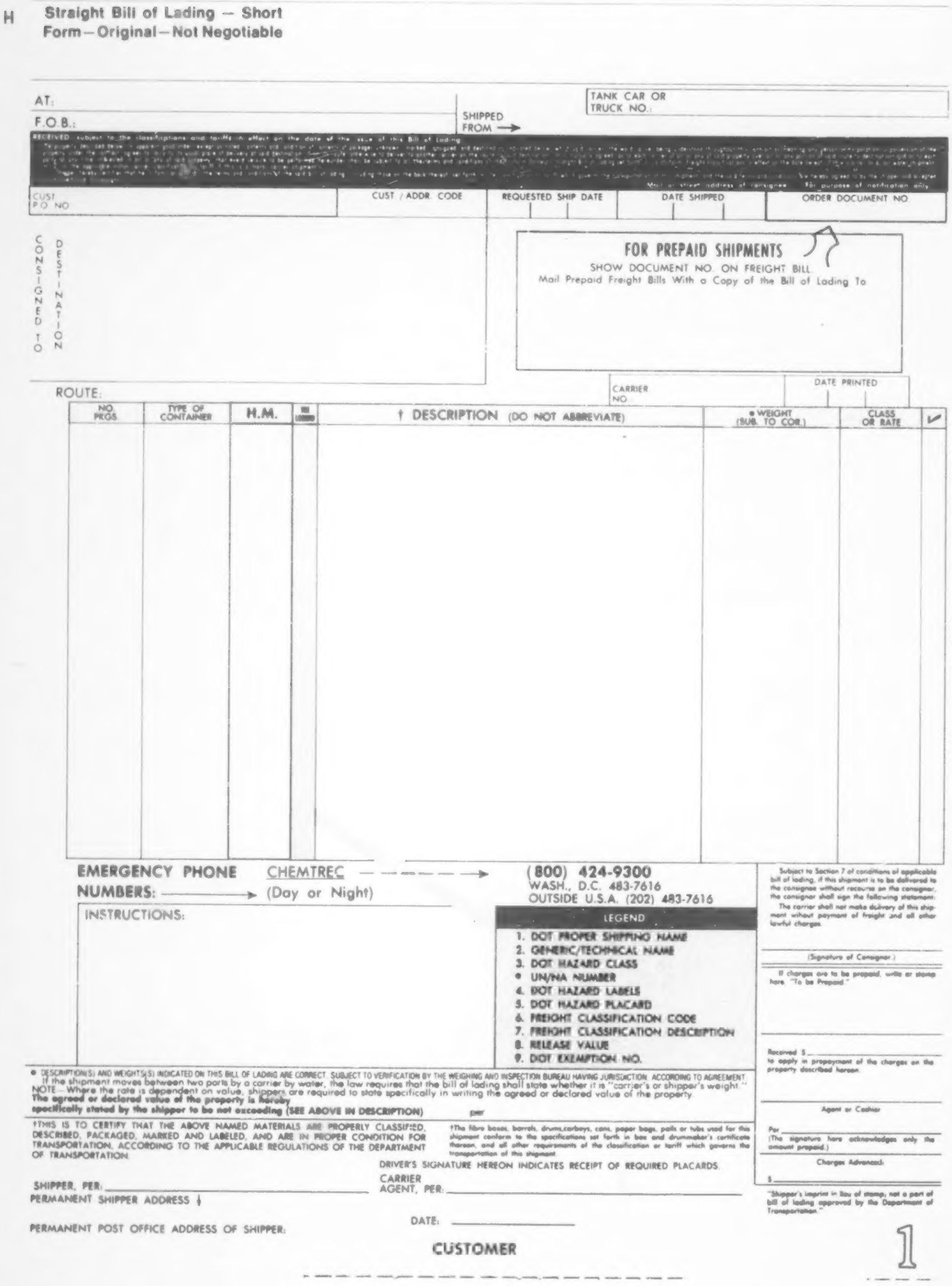
[32] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that releases of designated hazardous substances in quantities equal to or exceeding certain amounts, called Reportable Quantities (RQs), be reported to the National Response Center (See 49 U.S.C. 9656(a)). Prior to the passage of CERCLA, the U.S. Environmental Protection Agency (EPA) established RQs for designated hazardous substances under the Federal Water Pollution Control Act (FWPCA); RQs were set at 1, 10, 100, 1,000, and 5,000 pounds. CERCLA, enacted in 1980, assigned a statutory RQ of 1 pound to all designated hazardous substances (except those set under the FWPCA) but authorized EPA to adjust the RQs as appropriate. In April 1985, EPA promulgated RQs for 340 substances and proposed adjustments for 105 of the remaining 358 CERCLA designated substances. DOT decided not to regulate CERCLA substances (except RCRA hazardous wastes and FWPCA substances) until EPA adjusts the RQs. See Advance Notice of Proposed Rulemaking, Docket HM-145E, 48 F.R. 3596, Aug. 8, 1983. Several industry organizations petitioned the U.S. Department of Transportation (DOT) in 1981 to require all shippers of CERCLA designated substances in excess of 1 pound to prepare shipping papers. The petitioners believed that carriers needed to be notified that they were transporting hazardous substances as they were subject to liability requirements under CERCLA. The petition was denied by DOT. See 46 F.R. 58086, Nov. 30, 1981.

[33] U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on State and Local Activities," unpublished typescript, May 30, 1985; Charles Batten, National Transportation Safety Board, personal communication, April 1986; and Transportation Research Board, National Academy of Sciences, *Transportation of Hazardous Materials: Toward a National Strategy: Special Report 197* (Washington DC: National Academy Press, 1983).

[34] Certain shipments of ORM-A, B, C, and D materials do not have to be accompanied by shipping papers. See 49 CFR 172.200. These exceptions do not apply if the material is a hazardous substance or a hazardous waste.

[35] The U.S Department of Transportation regulations specify that a U.S. Environmental Protection Agency manifest may be used in place of a shipping paper. See 49 CFR 172.205. For additional information on hazardous waste requirements, see app. A.

Figure 4-2.—Sample Shipping Document



H **Straight Bill of Lading — Short Form — Original — Not Negotiable**

AT:

F.O.B.:

SHIPPED FROM →

TANK CAR OR TRUCK NO.:

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading,

Mail or street address of consignee — For purpose of notification only.

CUST P.O. NO	CUST / ADDR. CODE	REQUESTED SHIP DATE	DATE SHIPPED	ORDER DOCUMENT NO.

CONSIGNED TO

DESTINATION

FOR PREPAID SHIPMENTS

SHOW DOCUMENT NO. ON FREIGHT BILL

Mail Prepaid Freight Bills With a Copy of the Bill of Lading To

ROUTE:

CARRIER NO.

DATE PRINTED

NO. PKGS.	TYPE OF CONTAINER	H.M.		† DESCRIPTION (DO NOT ABBREVIATE)	* WEIGHT (SUB. TO COR.)	CLASS OR RATE	✓

EMERGENCY PHONE NUMBERS: → CHEMTREC → (Day or Night) **(800) 424-9300**

WASH., D.C. 483-7616

OUTSIDE U.S.A. (202) 483-7616

INSTRUCTIONS:

LEGEND

1. DOT PROPER SHIPPING NAME
2. GENERIC/TECHNICAL NAME
3. DOT HAZARD CLASS
- UN/NA NUMBER
4. DOT HAZARD LABELS
5. DOT HAZARD PLACARD
6. FREIGHT CLASSIFICATION CODE
7. FREIGHT CLASSIFICATION DESCRIPTION
8. RELEASE VALUE
9. DOT EXEMPTION NO.

* DESCRIPTION(S) AND WEIGHTS(S) INDICATED ON THIS BILL OF LADING ARE CORRECT. SUBJECT TO VERIFICATION BY THE WEIGHING AND INSPECTION BUREAU HAVING JURISDICTION. ACCORDING TO AGREEMENT.

If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight."

NOTE—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding (SEE ABOVE IN DESCRIPTION) per

†THIS IS TO CERTIFY THAT THE ABOVE NAMED MATERIALS ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED AND LABELED, AND ARE IN PROPER CONDITION FOR TRANSPORTATION, ACCORDING TO THE APPLICABLE REGULATIONS OF THE DEPARTMENT OF TRANSPORTATION.

†The fibre boxes, barrels, drums, carboys, cans, paper bags, pails or tubs used for this shipment conform to the specifications set forth in box and drummaker's certificate thereon, and all other requirements of the classification or tariff which governs the transportation of this shipment.

DRIVER'S SIGNATURE HEREON INDICATES RECEIPT OF REQUIRED PLACARDS.

SHIPPER, PER: ____________________

CARRIER AGENT, PER: ____________________

PERMANENT SHIPPER ADDRESS ↓

DATE: ____________

PERMANENT POST OFFICE ADDRESS OF SHIPPER:

Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

(Signature of Consignor.)

If charges are to be prepaid, write or stamp here, "To be Prepaid."

Received $ ____________ to apply in prepayment of the charges on the property described hereon.

Agent or Cashier

Per ____________

(The signature here acknowledges only the amount prepaid.)

Charges Advanced:

$ ____________

"Shipper's imprint in lieu of stamp, not a part of bill of lading approved by the Department of Transportation."

CUSTOMER

1

cation number assigned to it.[36] UN/NA identification numbers, which also must be marked on packages and bulk containers, correspond to emergency response information provided in a guidebook that is published and distributed nationally by DOT.[37] The DOT *Guidebook* contains information on potential health, fire, or explosion hazards and basic emergency action instructions. Isolation and evacuation information is also provided for a limited number of highly hazardous substances. DOT has requested $544,000 for fiscal year 1987 to revise the *Guidebook* and print 750,000 copies.[38]

In those instances where a specific technical name of a hazardous material is not listed in the Hazardous Materials Table, a proper shipping name must be selected from general description and n.o.s. (not otherwise specified) entries corresponding to the hazard class of the material.[39] In addition, special description requirements apply to certain types of materials, such as toxic inhalants, radioactive materials, hazardous substances, empty packagings, and each mode of transport.[40]

Markings.—DOT has established marking requirements for packages, freight containers, and transport vehicles. Shippers are required to mark all packages with a capacity of 110 gallons or less with the proper shipping name of the hazardous material, including its UN/NA identification number.[41] This is done so that the contents of a package can be identified if it is separated from its shipping papers. Requirements for intermodal portable tanks, highway cargo tanks, and rail tank cars specify that the UN/NA identification number be displayed on a placard or an orange rectangular panel.[42] Additional requirements are specified for liquids, packages containing ORM materials, and hazardous substances. For example, packages containing liquid hazardous materials must be marked "THIS SIDE UP" or "THIS END UP."[43] EPA also requires special markings for packages of hazardous wastes identifying the shipper and indicating that Federal law prohibits improper disposal of wastes.[44] Another type of marking requirement applies to container manufacturers and other persons who test, repair, or recondition containers; DOT specification numbers, serial numbers, and test inspection dates must be marked on containers as certification that specification requirements have been met.[45]

Labels.—Labels are symbolic representations of the hazards associated with a particular material. Figure 4-3 contains some examples of DOT labels. They are required on most packages and must be printed on or affixed near the marked shipping name.[46] The Hazardous Materials Table indicates which materials require labels. Shipments of limited quantities of certain hazardous materials may not require labeling; these exceptions are referenced in the Hazardous Materials Table (in column 5(a) under packaging exceptions). Additionally, some hazardous materials are exempt from labeling requirements. Exemptions are listed in 49 CFR 172.400 and include materials classed as ORM-A, B, C, D, or E (if other hazardous materials that must be labeled are not contained in the same package).

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[36] United Nations/North America (UN/NA) numbers consist of the prefix "UN" or "NA" followed by a four digit number. UN/NA numbers were adopted by the U.S. Department of Transportation in 1980 to facilitate international transportation of hazardous materials. The UN numbers are based on an international system developed by the United Nations Committee of Experts on the Transport of Dangerous Goods. The NA numbers identify materials not recognized for international shipment by the U.N. Committee except for transport between the United States and Canada. The change was intended to minimize the burden on shippers, avoid differing shipping paper descriptions and package markings for domestic and international shipments, and improve the capability of emergency response personnel to quickly identify hazardous materials. See 45 F.R. 34571, May 22, 1980.

[37] U.S. Department of Transportation, *1984 Emergency Response Guidebook*, P 5800.3 (Washington, DC: 1984). Additional information on emergency response training is provided in ch. 5.

[38] Paul Rothberg, *Hazardous Materials Transportation: Laws, Regulations, and Policy*, Issue Brief IB76026 (Washington, DC: Congressional Research Service, Science Policy Research Division, Mar. 11, 1985), p. 5.

[39] 49 CFR 172.101(c)(13).

[40] 49 CFR 172.203. The U.S. Department of Transportation recently amended the regulations for describing a packaging that contains the residue of a hazardous material. Placarding requirements for rail tank cars were also changed from "Empty" to "Residue." See 50 F.R. 39005, Sept. 26, 1985. Regulations for shipping descriptions, marking, labeling, placarding, and packaging of toxic inhalants, such as methyl isocyanate, were issued on Oct. 8, 1985. See 50 F.R. 41092.

[41] 49 CFR 172.301.

[42] 49 CFR 172.326, .328, and .330. Specific instructions regarding the display of identification number markings are provided in the regulations. It should be noted that identification numbers may not by displayed on a poison gas, radioactive, or explosives placard. See 49 CFR 172.332-.338.

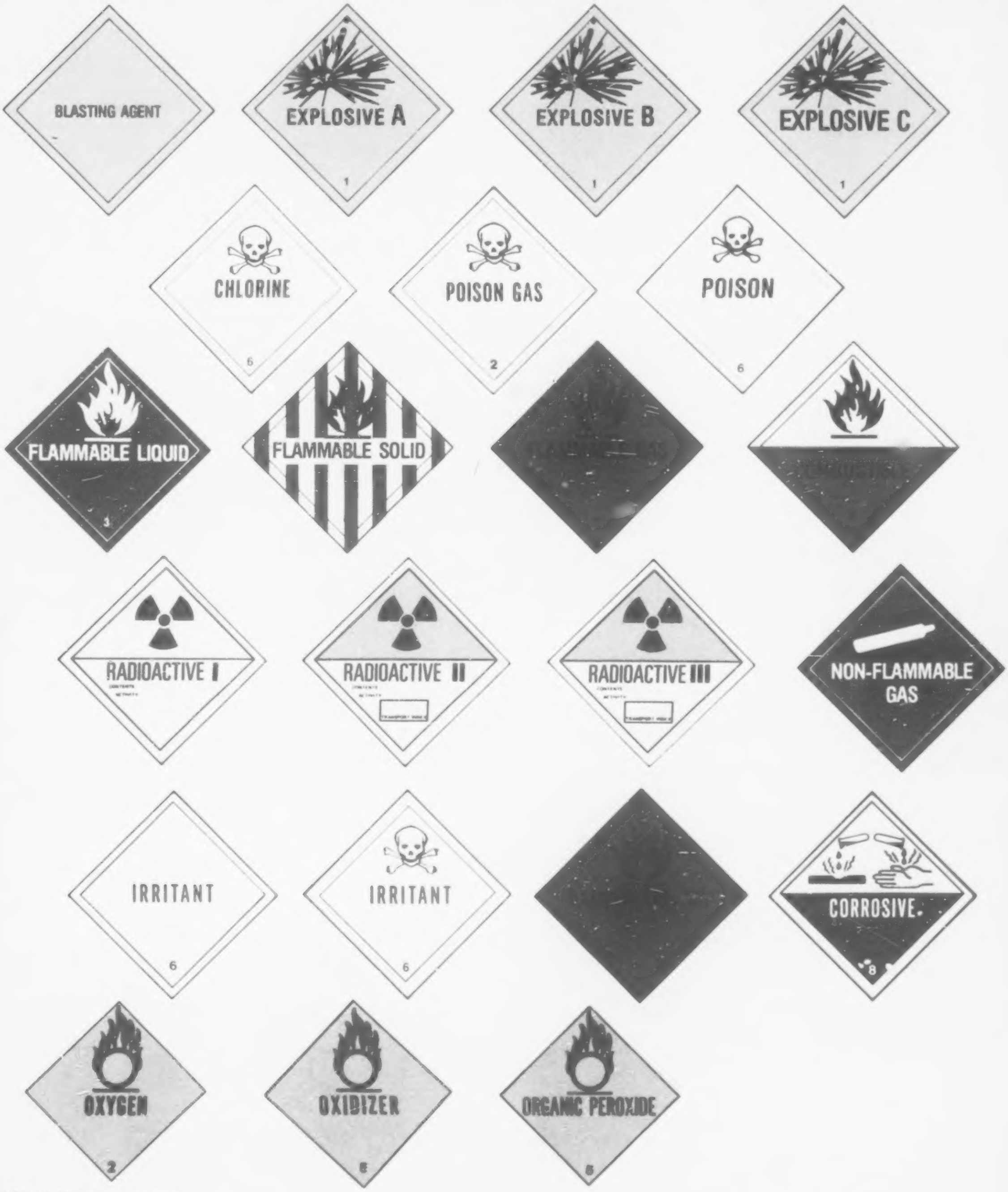
[43] 49 CFR 172.312, .316, and .324.

[44] 40 CFR 262.32. The U.S. Environmental Protection Agency's requirements for hazardous waste shipments are described in app. A.

[45] 49 CFR 173, 178, and 179.

[46] Requirements for the placement of labels can be found in 49 CFR 172.406. Label designs by hazard class are also specified in the regulations. See 49 CFR 407-450.

Figure 4-3.—Examples of Labels for Hazardous Materials Packages



SOURCE: 49 CFR 172, Subpart E.

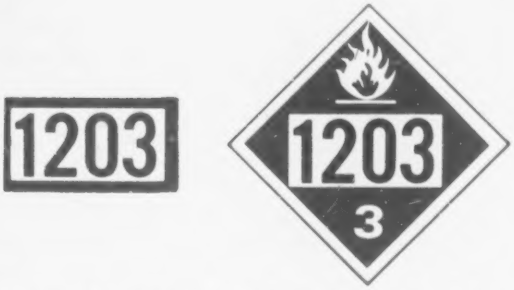


Photo credit: Office of Technology Assessment based on 49 CFR 172.332

1203 is the UN/NA identification number for gasoline.

Special labels, such as "MAGNETIZED MATERIALS" or "CARGO AIRCRAFT ONLY," are required under appropriate circumstances. In addition, packages containing materials that meet more than one hazard class definition may require multiple labels. For example, a material classed as a Poison B Liquid that also meets the definition of a Flammable Liquid must be labeled "POISON" and "FLAMMABLE LIQUID."[47]

Placards.—Placards are symbols that are placed on the ends and sides of motor vehicles, railcars, and freight containers indicating the hazards of the cargo. UN/NA identification numbers may be displayed on some placards, as noted above in the discussion of marking requirements. Placards are extremely important to emergency response personnel in the event of an accident because they are highly visible. Sample placards are shown in figure 4-4.

DOT has developed tables, presented in tables 4-5 and 4-6, that indicate the placards required for each hazard class. For mixed loads of some hazardous materials (those listed in table 4-6) shipped in freight containers, motor vehicles, or railcars, a "DANGEROUS" placard may be substituted for the placards required for each hazard class; however, if the weight of one material in a mixed load exceeds 5,000 pounds, a separate placard for it must also be affixed.[48] Placarding is the joint responsibility of shippers and carriers. Placard designs and rules for providing and affixing placards are specified by DOT.[49]

Placards are not required for all shipments of hazardous materials, such as etiologic agents; materials classed as ORM-A, B, C, D, or E; or limited quantities of hazardous materials.[50] Moreover, motor vehicles or freight containers transported by highway containing less than 1,000 pounds of certain types of hazardous materials (those listed in table 4-6) do not have to be placarded. This exclusion also applies to motor vehicles or freight containers carried by railcar (e.g., piggyback service).[51]

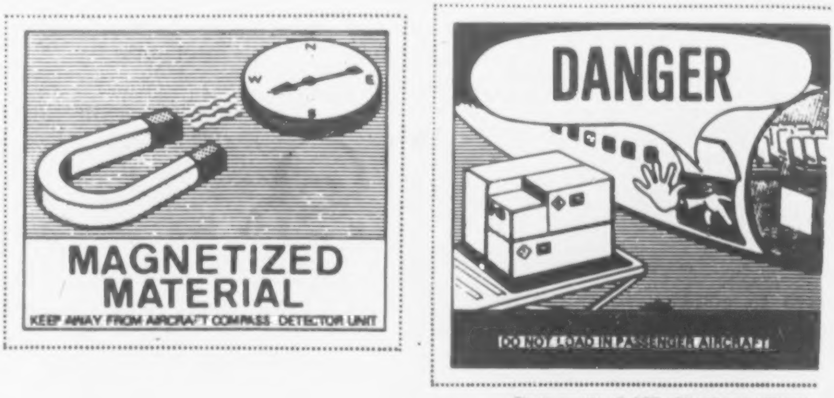

N
W
E
S
MAGNETIZED MATERIAL
KEEP AWAY FROM AIRCRAFT COMPASS DETECTOR UNIT
DANGER
DO NOT LOAD IN PASSENGER AIRCRAFT

Photo credit: 49 CFR 172.446 and 172.448

Two examples of special labels required by the Department of Transportation.

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[47] 49 CFR 172.402, .403, .404, and .405.

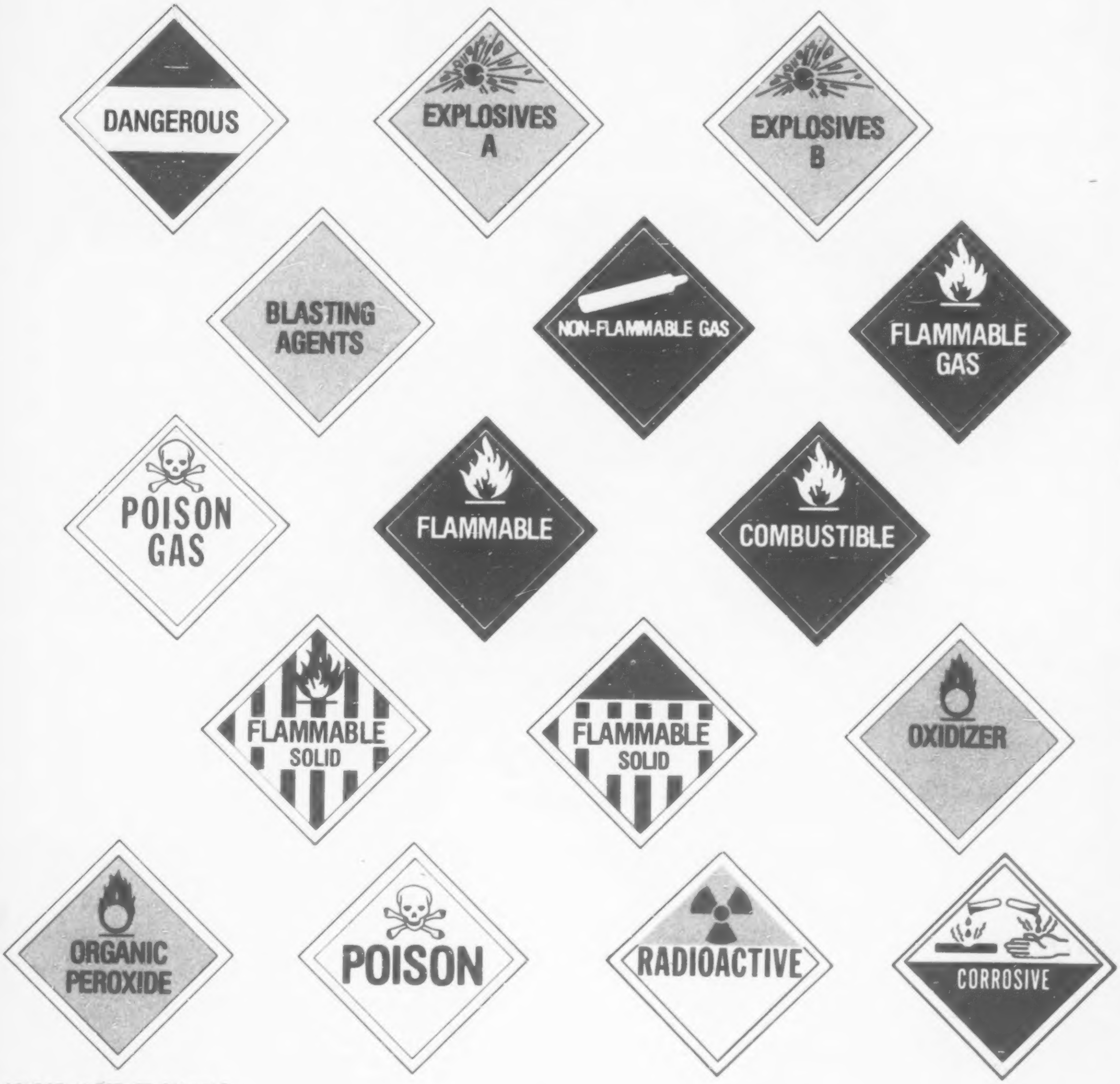
[48] 49 CFR 172.504(b).

[49] Rules for providing and affixing placards are contained in 49 CFR 172.506, .507, .508, .512, and .514. Special placarding provisions for railcars are listed in 49 CFR 172.510. Display and design specifications are specified in 49 CFR 172.516-.558.

[50] 49 CFR 172.500.

[51] 49 CFR 172.504(c).

Figure 4-4.—Examples of Hazardous Materials Placards



SOURCE: 49 CFR 172, Subpart F.

Packaging Requirements.—The historical summary at the beginning of this chapter underscores the fact that current packaging regulations, published in 49 CFR 173, 178, and 179, are a compilation of detailed specifications developed over a 70-year period. Part 173 indicates the types of packages authorized for each hazard class as well as regulations governing the reuse and reconditioning of packagings and qualification, maintenance, and use requirements for rail tank cars, highway cargo tanks, intermodal portable tanks, and cylinders. Small quantities of some hazardous materials may be trans-

Table 4-5.—Department of Transportation Placarding Table 1

If the motor vehicle, rail car, or freight container contains a material classed (described) as—	The motor vehicle, rail car, or freight container must be placarded on each side and each end—
Class A explosives	EXPLOSIVES A.[1]
Class B explosives	EXPLOSIVES B.[2]
Poison A	POISON GAS.[1]
Flammable solid (DANGEROUS WHEN WET label only)	FLAMMABLE SOLID W.[3]
Radioactive material	RADIOACTIVE.[4, 5]
Radioactive material:	
Uranium hexafluoride, fissile (containing more than 1.0 pct U^{235})	RADIOACTIVE[4] AND CORROSIVE.[6]
Uranium hexafluoride, low specific activity (containing 1.0 pct or less U^{235})	RADIOACTIVE[4, 5] AND CORROSIVE.[6]

[1] See § 172.510(a).

[2] EXPLOSIVES B placard not required if the freight container, motor vehicle, or rail car contains class A explosives and is placarded EXPLOSIVES A as required.

[3] FLAMMABLE SOLID "W" placard is required only when the DANGEROUS WHEN WET label is specified in § 172.101 for a material classed as a Flammable solid.

[4] Applies only to any quantity of packages bearing the RADIOACTIVE YELLOW III label. (See § 172.403.)

[5] See § 173.403, for full-load shipments of radioactive materials meeting the definition of low specific activity when transported pursuant to § 173.425(b).

[6] CORROSIVE placard not required for shipments of less than 1000 pounds gross weight.

SOURCE: 49 *CFR* 172.504.

Table 4-6.—Department of Transportation Placarding Table 2

If the motor vehicle, rail car or freight container contains a material classed (described) as—	The motor vehicle, rail car, or freight container must be placarded on each side and each end—
Class C explosives	DANGEROUS.[1, 9]
Blasting agents	BLASTING AGENTS.[9, 10]
Nonflammable gas	NONFLAMMABLE GAS.[8]
Nonflammable gas (chlorine)	CHLORINE.[7]
Nonflammable gas (fluorine)	POISON.
Nonflammable gas (oxygen, cryogenic liquid)	OXYGEN.
Flammable gas	FLAMMABLE GAS.[8]
Combustible liquid	COMBUSTIBLE.[3, 4]
Flammable liquid	FLAMMABLE.
Flammable solid	FLAMMABLE SOLID.[5]
Oxidizer	OXIDIZER.[9, 10]
Organic peroxide	ORGANIC PEROXIDE.
Poison B	POISON.
Corrosive material	CORROSIVE.[6]
Irritating material	DANGEROUS.

[1] Applies only to a class C explosive required to be labeled with an EXPLOSIVE C label.

[2] [Reserved]

[3] COMBUSTIBLE placard required only when a material classed as a combustible liquid is transported in a packaging having a rated capacity of more than 110 gallons, a cargo tank, or a tank car.

[4] A FLAMMABLE placard may be used on a cargo tank or portable tank during transportation by highway, rail or water, and on a compartmented tank car containing materials classed as Flammable liquid and Combustible liquid. However, no EMPTY placard may be displayed on an "empty" Combustible liquid tank car.

[5] Except when offered for transportation by water, a FLAMMABLE placard may be displayed in place of a FLAMMABLE SOLID placard except when a DANGEROUS WHEN WET label is specified for the material in sec. 172.101. (See table 1, this section.)

[6] See § 173.245(b) of this subchapter for authorized exceptions.

SOURCE: 49 *CFR* 172.504.

ported in nonspecification packaging if specified performance tests and other requirements are met.[52] The Hazardous Materials Table references the appropriate section of Part 173 for each hazardous material and packaging exceptions for limited quantities of certain hazardous materials.

Parts 178 and 179 contain the specifications for each package type including test standards that must be followed by container manufacturers. Hundreds of packaging exemptions are still issued by RSPA staff each year, authorizing the use of packagings that differ from approved DOT specifications. For a more detailed discussion of packaging regulations, see chapter 3.

International Regulations.—Two major international standard-setting bodies publish recommended requirements for intermodal shipments of hazardous materials: the United Nations (U.N.) and the International Atomic Energy Agency (IAEA). RSPA representatives participate in the development of these international codes and others that deal solely with air and water transportation (see discussion below). Comments are solicited from industry and the public on proposed international regulatory activities, even though a formal public participation mechanism, comparable to the Administrative Procedures Act for domestic regulations, does not exist.[53] Regulations for the transportation of hazardous materials adopted by these international agencies are applicable to U.S. shippers and carriers that trade abroad.

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[52] These exceptions apply to small quantities of flammable liquids, flammable solids, oxidizers, organic peroxides, corrosive materials, Poison B, and ORM-A, B, C, and radioactive materials that also meet the definition of one or more of these hazard classes. See 49 CFR 173.4.

The main body of the **United Nations** dealing with hazardous materials transportation policy is the Economic and Social Council (ECOSOC), which reports to the U.N. General Assembly in New York. ECOSOC works through specialized commissions and committees. The primary groups concerned with hazardous materials are the Economic Commission for Europe and the Committee of Experts on the Transport of Dangerous Goods. The Committee of Experts is comprised of 10 members including the United States, Canada, several European Nations, and the U.S.S.R.[54]

The Committee of Experts has published a set of recommendations regarding classification and identification numbering systems for hazardous materials, labeling, and placarding requirements, and the use of objective performance standards for nonbulk packaging.[55] DOT has adopted some of the U.N. recommendations, such as the identification numbering systems for hazardous materials. Other recommendations, such as performance standards, have not yet been adopted by DOT, although an advance notice proposing their adoption has been published in the *Federal Register*.[56] Additional information on the U.N. performance standards is presented in chapter 3.

The **Canadian Government** has recently adopted new rules, the Transportation of Dangerous Goods (TDG) Regulations, based on the U.N. system.[57] Transport Canada, a multimodal national agency responsible for these requirements, issued rules in July 1985 covering classification, placarding, marking, labeling, and shipping papers. In October 1985, DOT issued a rule permitting shipments between Canada and the United States in conformance with Canada's TDG Regulations and certain additional DOT requirements. Packaging standards, except for specific types of hazardous materials (limited quantities and consumer commodities), have not yet been published by Transport Canada.[58]

The **International Atomic Energy Agency** first became involved with the transportation of radioactive materials in the late 1950s. The first set of recommendations—*Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6*—was published in 1961. The recommendations have been revised and updated over the years and serve as the basis for regulatory programs established by IAEA member nations. DOT has incorporated Safety Series No. 6 into its regulations by reference with certain modifications for application to radioactive materials being imported to or exported from the United States.[59] Other international organizations such as the International Maritime Organization and the International Civil Aviation Organization (discussed below) have incorporated IAEA requirements into their codes. IAEA recommendations include package design, testing, and inspection procedures; requirements for limiting human exposure to radiation; and controls for transport and storage while in transit.

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[53] The Administrative Procedures Act (APA) prescribes rules for the adoption of regulations by Federal agencies. Agencies are required to publish proposed and final rulemakings in the *Federal Register* and provide an opportunity for public comment. Any international requirements proposed for incorporation into the U.S. Department of Transportation's hazardous materials regulations are subject to APA procedures. See 5 U.S.C. 553.

[54] A working group under the Committee of Experts, the Group of Rapporteurs on the Transport of Dangerous Goods, is responsible for developing detailed positions on various issues for formal consideration by the full committee. Another subgroup is the Group of Experts on Explosives.

[55] United Nations, *Transport of Dangerous Goods—Recommendations of the Committee of Experts on the Transport of Dangerous Goods*, third revised edition (New York: 1984).

[56] 47 FR 16268, Apr. 15, 1982.

[57] Until the early 1970s, the U.S. Department of Transportation's hazardous materials regulations were adopted by the Canadian Transport Commission (CTC) and applied to rail transport in Canada (49 CFR 173.8 stated that hazardous materials shipped in accordance with CTC regulations were acceptable for transport in the United States). CTC did not establish national regulations for the highway mode. Thus, shippers and carriers involved with transborder shipments of hazardous materials were not concerned with conflicting regulatory requirements. As new regulations were adopted by the United States in the late 1970s, CTC did not amend its code accordingly.

[58] 50 FR 41516, Oct. 11, 1985. 49 CFR 173.8 was replaced by a new section, 49 CFR 171.12a, describing requirements for U.S.-Canadian shipments.

[59] 49 CFR 171.12(e), 173.416, and 173.417. Radioactive materials passing through the United States in the course of being shipped between places outside the United States are included.

Highway

RSPA regulations for the highway mode apply to common, contract, and private carriers. Part 177 of 49 CFR specifies regulations for accepting freight, loading and unloading, stowage, routing, and handling. A special chart, shown in figure 4-5, is provided in the regulations indicating materials that must not be loaded or stored together (similar charts are provided for other transport modes). A general requirement applicable to all highway shipments is that they be transported without unnecessary delay, from loading to arrival at their destinations.[60] Recognizing the safety concerns associated with tunnels, the regulations allow State and municipal requirements restricting hazardous materials shipments (except radioactive materials) through vehicular tunnels used for mass transport.[61] Other in-transit regulations cover the actions that must be taken by carriers and shippers in the event of an

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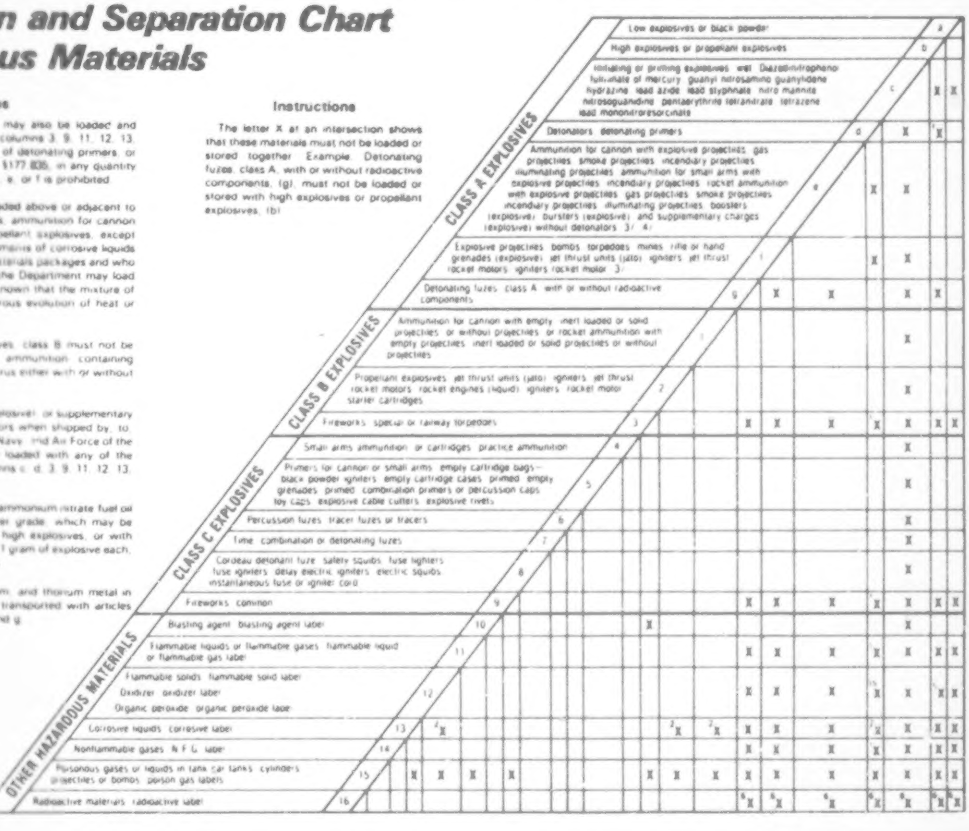
[60] 49 CFR 177.853(a).

[61] 49 CFR 177.810. When the U.S. Department of Transportation issued HM-164, this section was amended to exclude shipments of radioactive materials so that States would be able to: "evaluate the site-specific risks involved over various routes without being hampered by locally imposed constraints which may be counterproductive." See 46 F.R. 5308, Jan. 19, 1981.

Figure 4-5.—Department of Transportation Segregation and Separation Chart for the Highway Mode

Segregation and Separation Chart of Hazardous Materials


Low explosives or black powder a
High explosives or propellant explosives b
Initiating or priming explosives, wet Diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead azide, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene, lead mononitroresorcinate c
Detonators, detonating primers d
Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles, ammunition for small arms with explosive projectiles, incendiary projectiles, rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles, boosters (explosive), bursters (explosive), and supplementary charges (explosive) without detonators 3/ 4/ e
Explosive projectiles, bombs, torpedoes, mines, rifle or hand grenades (explosive), jet thrust units (jato), igniters, jet thrust rocket motors, igniters rocket motor 3/ f
Detonating fuzes, class A, with or without radioactive components g
CLASS A EXPLOSIVES
Ammunition for cannon with empty, inert loaded or solid projectiles, or without projectiles, or rocket ammunition with empty projectiles, inert loaded or solid projectiles or without projectiles 1
Propellant explosives, jet thrust units (jato), igniters, jet thrust rocket motors, rocket engines (liquid), igniters, rocket motor starter cartridges 2
Fireworks, special or railway torpedoes 3
CLASS B EXPLOSIVES
Small arms ammunition, or cartridges, practice ammunition 4
Primers for cannon or small arms, empty cartridge bags—black powder igniters, empty cartridge cases, primed, empty grenades, primed, combination primers or percussion caps, toy caps, explosive cable cutters, explosive rivets 5
Percussion fuzes, tracer fuzes or tracers 6
Time, combination or detonating fuzes 7
Cordeau detonant fuze, safety squibs, fuse lighters, fuse igniters, delay electric igniters, electric squibs, instantaneous fuse or igniter cord 8
Fireworks, common 9
CLASS C EXPLOSIVES
Blasting agent, blasting agent label 10
Flammable liquids or flammable gases, flammable liquid or flammable gas label 11
Flammable solids, flammable solid label
Oxidizer, oxidizer label
Organic peroxide, organic peroxide label 12
Corrosive liquids, corrosive label 13
Nonflammable gases, N F G label 14
Poisonous gases or liquids in tank car tanks, cylinders, projectiles or bombs, poison gas labels 15
Radioactive materials, radioactive label 16
OTHER HAZARDOUS MATERIALS

Footnotes

1 Detonators, class C explosives, may also be loaded and transported with articles named in columns 3, 9, 11, 12, 13, and 14. Loading and transportation of detonating primers, or detonators, except as prescribed in §177.835, in any quantity with articles named in columns b, c, e, or f is prohibited.

2 Corrosive liquids must not be loaded above or adjacent to flammable solids, oxidizing materials, ammunition for cannon with or without projectiles, or propellant explosives, except that shippers loading truckload shipments of corrosive liquids and flammable solids or oxidizing materials packages and who have obtained prior approval from the Department may load such materials together when it is known that the mixture of contents would not cause a dangerous evolution of heat or gas.

3 Explosives, class A, and explosives, class B must not be loaded or stored with chemical ammunition containing incendiary charges or white phosphorus either with or without bursting charges.

4 Bursters (explosive), boosters (explosive), or supplementary charges (explosive) without detonators when shipped by, to, or for the Departments of the Army, Navy, and Air Force of the United States Government may be loaded with any of the articles named except those in columns c, d, 3, 9, 11, 12, 13, 14, 15 and 16.

5 Does not include blasting agents, ammonium nitrate fuel oil mixtures, ammonium nitrate, fertilizer grade, which may be loaded, transported, or stored with high explosives, or with detonators containing not more than 1 gram of explosive each, excluding ignition and delay charges.

6 Normal uranium, depleted uranium, and thorium metal in solid form may also be loaded and transported with articles named in columns a, b, c, d, e, f, and g.

Instructions

The letter X at an intersection shows that these materials must not be loaded or stored together. Example: Detonating fuzes, class A, with or without radioactive components, (g), must not be loaded or stored with high explosives or propellant explosives, (b).

SOURCE: 49 *CFR* 177.848.

accident.[62] In addition, carriers of flammable cryogenic liquids in portable tanks or cargo tanks are required to register with RSPA and undergo training.[63]

While routing regulations are generally considered to be an appropriate local-level responsibility, RSPA has established a national highway routing rule for radioactive materials.[64] This rule, commonly referred to as DOT Docket HM-164, was promulgated because a large number of States and localities had proposed or enacted legislation banning or restricting the transport of radioactive materials through their jurisdictions. Following an extensive public comment period, DOT concluded that, "the public risks in transporting these materials by highway are too low to justify the unilateral imposition by local governments of bans and other severe restrictions."[65] However, DOT found that certain actions could further minimize the risks associated with such shipments. Thus, HM-164 requires carriers of all placarded shipments of radioactive materials, including radiopharmaceuticals and low-level wastes, to operate on routes that minimize radiological risk.[66] Carriers of high-level radioactive materials must operate over a "preferred" route that is selected to reduce transit time. Such a route consists of either an Interstate highway system (including the use of an Interstate bypass around a city when available) or an alternative State-designated route selected by a State routing agency in accordance with DOT guidelines.[67] Drivers of vehicles that transport high-level radioactive materials are also required to receive written training, and carriers must prepare a written route plan.

An appendix to HM-164 provides policy guidance for State and local authorities for establishing requirements that are consistent with Federal law and regulations. The implementation of HM-164 by RSPA, Federal routing guidelines, and existing State and local routing restrictions are discussed later in this chapter.

The Bureau of Motor Carrier Safety (BMCS) within the Federal Highway Administration is responsible for developing some hazardous materials regulations and enforcing RSPA regulations for the highway mode, including requirements for tank truck manufacture and maintenance. BMCS, under its general authority to set motor carrier safety standards, also regulates motor carrier operations, drivers, and vehicles used for transporting hazardous materials.

Motor carrier safety regulations, incorporated by reference into RSPA's hazardous materials regulations in 1978, are located in Parts 301 to 399 of 49 CFR. However, the driver qualification regulations are limited; for example, while drivers must take a written test, it is an open book exam and a passing grade is not required.[68] In addition, the motor carrier regulations do not provide for driver disqualification based on a driver's cumulative record of convictions, and the disqualifying driver offenses apply only when a driver operates a commercial vehicle and is on duty at the time of an offense.[69] Furthermore, Federal regulations cover mainly Interstate drivers, and State driver requirements vary considerably.* Improvements in driver qualification and training requirements have been proposed; these suggestions and State requirements are described later in this chapter.

Special regulations for the transportation of hazardous materials, contained in Part 397, prescribe requirements for compliance with Federal, State, and local laws; parking; attendance and surveillance of vehicles; and operating (e.g., requirements for fueling and examining tires). A general routing requirement instructs carriers to avoid routes that go through or near heavily populated areas, places where crowds are assembled, tunnels, narrow streets, or alleys, unless a practicable alternative route does not exist.[70] BMCS also requires written route plans for shipments of Class A or Class B explosives by motor vehicle that comply with the general routing rule.[71] However, when the motor carrier safety regulations were incorporated into the hazardous materials regulations, these routing rules were not incorporated. Another provision in the motor carrier regulations, requiring compliance with State and local regulations unless they are at variance with more stringent Federal regulations, was not incorporated.

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[62] 49 CFR 177, Subpart D.

[63] 49 CFR 177.816 and 177.826.

[64] 49 CFR 177.825. The routing rule, Docket HM-164, was published on Jan. 19, 1981, 46 F.R. 5316.

[65] 46 F.R. 5299, Jan. 19, 1981. See also 43 F.R. 36492, Aug. 17, 1978, and 45 F.R. 7140, Jan. 31, 1980.

[66] 49 CFR 177.825 (a).

[67] 49 CFR 177.825(b). This provision applies to highway route controlled quantities of radioactive materials as defined in 49 CFR 173.403(i).

[68] 49 CFR 391.35.

[69] See 49 CFR 391.15 and National Transportation Safety Board, *Safety Effectiveness Evaluation of Detection and Control of Unsafe Interstate Commercial Drivers* (Washington, DC: Feb. 15, 1980), pp. 15-18.

*Federal motor carrier regulations do apply to intrastate carriers of hazardous wastes, hazardous substances, and flammable cryogenics.

[70] 49 CFR 397.9(a). This requirement does not apply to radioactive materials covered by HM-164, 49 CFR 177.825.

In addition, BMCS has established minimum financial responsibility requirements for private and for-hire carriers of hazardous materials as required by the Motor Carrier Act of 1980. Minimum levels of coverage have been set at $1 million and $5 million, depending on the nature of the cargo. However, exemptions from these requirements have been established for intrastate nonbulk carriers of hazardous materials except high-level radioactive materials and motor vehicles with gross vehicle weight ratings of less than 10,000 pounds except for vehicles used to transport Class A or B explosives, poison gases, or high-level radioactive materials.[72]

Another BMCS activity is the administration of the Motor Carrier Safety Assistance Program (MCSAP), which provides assistance to States for enforcement of motor carrier regulations, including some of those governing hazardous materials transportation on public roads.[73] MCSAP is discussed later in this chapter.

In addition to the DOT regulations, the National Motor Freight Traffic Association, a division of the American Trucking Association, publishes the National Motor Freight Classification (NMFC) which prescribes packaging to be used to ship all goods by highway, including hazardous materials. Except in one instance, the NMFC rules are not referenced in the Federal regulations, but they do provide guidance for shippers handling materials that do not have to be transported in DOT specification containers. In addition, noncompliance with the NMFC requirements may limit the ability of a shipper to collect from a motor carrier in the event of damages arising during transport.

Rail

Hazardous materials regulations for rail transport appear in 49 CFR 174. The regulations contain general operating, handling, and loading and unloading requirements, as well as detailed requirements for various hazard classes. For example, specific requirements for segregating hazardous materials in a car and for the placement of cars containing certain types of material are included.[74] Carriers are also instructed to forward shipments of hazardous materials within 48 hours after acceptance at the originating point, or receipt at any yard, transfer station, or interchange point.[75] Special loading and bracing requirements for container-on-flatcar, trailer-on-flatcar, and portable tanks are provided, and procedures for unloading tank cars are also specified.[76]

The Federal Railroad Administration (FRA) enforces regulations pertaining to the transportation of hazardous materials by rail, including those governing the manufacture and maintenance of tank cars used to ship hazardous materials. Additionally, FRA has jurisdiction over all areas of rail safety such as track maintenance, equipment standards, and operating practices. Rail safety regulations are published in 49 CFR Parts 209 to 236.

As noted previously, AAR has been involved in developing hazardous materials regulations since the early 1900s. However, the organization currently plays a less prominent role in the regulatory process. Prior to the formation of DOT, counsel for ICC recommended withdrawal of the broad delegation of authority that had been granted to the Bureau of Explosives, a legal opinion reiterated by DOT when it took over ICC's functions in 1967. In the late 1970s, DOT assumed responsibility for approving regulatory exemptions, a task performed by the Bureau of Explosives for decades.[77] In 1985, the

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[71] 49 CFR 397.9(b). The carrier must furnish a copy of the plan to the driver. Drivers may prepare written plans when trips begin at locations other than the carrier's terminal.

[72] 49 CFR 387.

[73] The Motor Carrier Safety Assistance Program was authorized by the Surface Transportation Act of 1982, Public Law 97-424.

[74] See 49 CFR 174.81 for cargo segregation requirements; a table, similar to the one for highway shipments (see figure 4-5) is provided. Regulations regarding the placement of cars can be found in 49 CFR 174.83-.93.

[75] 49 CFR 174.14.

[76] 49 CFR 174.61, 174.63, and 174.67.

[77] U.S. Department of Transportation Docket No. HM-163.

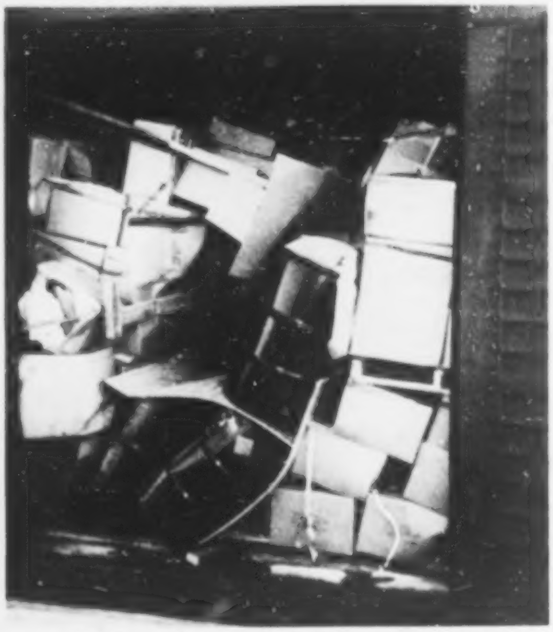

Photo credit: Research and Special Programs Administration, DOT

Inadequate blocking and bracing of containers for rail transportation can cause damage and spills.

Bureau of Explosives was renamed Hazardous Materials Systems; it continues to classify and review new explosives and other materials.

Other AAR groups publish equipment standards and specifications, and engineering offices certify construction and repair shops. The AAR Tank Car Committee is involved in all aspects of tank car construction, maintenance, and repair, including those used for hazardous and nonhazardous materials. **The committee must approve new tank car designs before they are submitted to DOT. The DOT hazardous materials regulations specify procedures for securing AAR approval of tank cars or changes to existing specifications, and providing certificates of construction.**[78]

Another organization involved with rail transport is the Uniform Classification Committee, which publishes the Uniform Freight Classification (UFC). The UFC serves a similar function to that of the NMFC for the highway mode.

Air

RSPA regulations for the air mode are specified in 49 CFR 175. They cover special requirements for certain hazard classes as well as general loading, unloading, and handling requirements. The Hazardous Materials Table in 49 CFR 172 indicates the quantities per package of materials that may be transported on passenger and cargo aircraft as well as those materials, such as Class A explosives, forbidden from being offered or accepted for transport.[79] The regulations also require that pilots be informed of any hazardous materials carried in an aircraft.[80]

Responsibility for the enforcement of hazardous materials regulations for the air mode lies with FAA. Inspections of hazardous materials packages on domestic and foreign carriers are conducted at U.S. airports and in airport cargo-handling areas. FAA also issues and enforces general safety rules and regulations, such as manufacture, operation, and maintenance requirements for aircraft.

The Air Transport Association represents the concerns of domestic airlines. Its Restricted Articles Board was responsible for publishing "CAB Restricted Articles Tariff No. 6-D" in 1965. Tariff 6-D originally contained a restatement of the DOT hazardous materials regulations for air shipments as well as additional requirements established by air carriers. In 1977, Tariff 6-D was replaced by Circular 6-D in response to a CAB order prohibiting the publication of portions of the CFR in tariffs; Tariff 6-D was rewritten to include only more restrictive carrier regulations.[81] Federal regulations were effectively replaced by Circular 6-D, because it was more readable and useful as a daily tool and could be updated more easily to accommodate regulatory amendments.

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[78] 49 CFR 179.3, .4 and .5.

[79] Quantity limitations aboard aircraft are specified in 49 CFR 175.75. No person may carry more than 50 pounds net weight of hazardous materials (and in addition thereto, 150 pounds net weight of nonflammable compressed gas) on a passenger-carrying aircraft in an accessible cargo compartment or freight container, an accessible cargo container, or an accessible cargo compartment in a cargo-only aircraft. Hearings were held by the U.S. Department of Transportation during 1985 in response to a petition for rulemaking submitted by Japan Airlines to remove current weight limitations of 50 pounds allowed on passenger aircraft. See 50 F.R. 6013, Feb. 13, 1985.

[80] 49 CFR 175.33.

[81] Civil Aeronautics Board Order 77-2-59.

The role of the Restricted Articles Board has been diminished in recent years due to deregulation of domestic air carriers and the increasing influence of international organizations such as the International Air Transport Association (IATA). IATA publishes restricted articles regulations for international use similar to those in Circular 6-D. Increasing numbers of domestic carriers are relying exclusively on the IATA regulations instead of Circular 6-D, as carriers prefer to follow only one set of instructions.[82] The Restricted Articles Board continues to work with carriers in restricting the types of hazardous materials accepted for transport beyond the limitations set by DOT.

In 1982, the International Civil Aviation Organization (ICAO), an affiliate of the United Nations, adopted Technical Instructions (TI) based on the U.N. recommendations for air transportation of dangerous goods. All air shipments from the United States and all U.S. flag carriers must adhere to the TI, as the United States is a signatory to the convention under which they were adopted. In addition, DOT has authorized the use of the TI for domestic air transportation and for any highway transportation related to the air distribution of a material.[83] IATA has revised its regulations so that they are based primarily on the ICAO requirements.

Photo credit: Sealand, provided by Railway Age

Hazardous materials travel by all modes of transportation.

Water

RSPA regulations for the water mode apply only to nonbulk shipments.[84] Promulgated in 49 CFR 176, the regulations address requirements for accepting freight, loading and unloading, stowage, and handling. Carriers or agents are also required to prepare a dangerous cargo manifest, which must be kept in a designated holder on or near the vessel's bridge.[85]

The Coast Guard regulates bulk transport by water. Requirements for the design, construction, equipment, maintenance, and inspection of commercial vessels, including those used for bulk hazardous material shipments are contained in 46 CFR Parts D, I, N, and O. Additional requirements for certain ships and barges that carry bulk oil shipments are prescribed in 33 CFR 157. Coast Guard requirements for dangerous cargo require vessels to notify the appropriate captain of the port in advance of arrivals and departures.[86]

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[82] Frank Black, Air Transport Association of America, written communication, Feb. 12, 1986.

[83] 49 CFR 171.11.

[84] Vessels subject to regulation are specified in 49 CFR 176.5. For example, public vessels not engaged in commercial service and vessels of 500 gross tons or smaller, engaged in fisheries are not covered.

[85] The manifest includes information about the vessel and the cargo and is prepared based on information from shipping papers. 49 CFR 176.30.

[86] 33 CFR 211 and 213. Dangerous cargo includes Class A explosives, oxidizing materials or blasting agents, large quantity radioactive materials or certain fissile radioactive materials, and bulk shipments of a specified list of materials (see 33 CFR 160.203 and 46 CFR 153 (table 1)). General prenotification requirements have also been established for all vessels on voyages of 24 hours or more destined for the United States and for vessels bound for ports on the Great Lakes (33 CFR 160.207 and 160.209).

Coast Guard inspection and enforcement activities are carried out in port areas and on domestic and foreign ships and barges operating in the navigable waters of the United States. The National Cargo Bureau, Inc., has been authorized by the Coast Guard to assist with the administration of the hazardous materials regulations applicable to the safe loading of vessels. Surveyors employed by the Bureau inspect vessels to determine their suitability for loading and stowing hazardous materials, recommend stowage requirements, and issue certificates of loading.[87]

The Safety of Life at Sea convention of 1960 outlined requirements for ship construction and safety that set the stage for the development of an international maritime code pertaining to the movement of hazardous materials. The International Maritime Organization (IMO), formerly called the Intergovernmental Maritime Consultative Organization, worked with the U.N. Committee of Experts to establish requirements addressing classification, identification, documentation, labeling, marking, and packaging.[88] These requirements, referred to as the International Maritime Dangerous Goods (IMDG) Code, may be followed, with certain limitations, by shippers and carriers who import to or export from the United States.[89] In addition, RSPA has authorized the use of IMDG requirements for packaging, marking, labeling, classification, description, certification, and placarding for most domestic shipments by vessel, as well as for transportation by motor vehicle used in connection with the discharge or loading of a vessel if the vehicle does not operate on a public street or highway.[90] To facilitate the use of the IMDG Code, RSPA has incorporated an optional Hazardous Materials Table into 49 CFR based on IMO classifications and requirements.[91]

Related Federal Agencies and Programs

While DOT has primary jurisdiction over the transportation of hazardous materials, three other Federal agencies have overlapping regulatory responsibilities—EPA, NRC, and OSHA. In addition, ICC grants motor carriers authorization to operate and requires carriers subject to its jurisdiction to publish rates. DOE and DOD as shippers of hazardous materials have also established transportation programs and requirements. Another agency, NTSB, is concerned with investigations of transportation accidents.

Environmental Protection Agency

EPA manages several programs that affect the transportation of certain hazardous materials. The Resource Conservation and Recovery Act (RCRA) requires EPA to establish requirements for transporters of hazardous wastes; EPA has adopted DOT's regulations for hazard communication, packaging, and reporting discharges and has enacted additional notification, marking, manifest, and cleanup requirements. However, the characteristics used by EPA to identify a waste are different from DOT's hazard classes. Thus, shippers and carriers of hazardous wastes must understand and comply with both classification systems. A Memorandum of Understanding between EPA and DOT refers to investigation, enforcement, and information-sharing responsibilities under RCRA.[92] Appendix A contains additional information on EPA and DOT regulations for the transportation of hazardous wastes.

In 1981, a guidance manual for shippers and carriers of hazardous wastes was prepared by EPA and DOT to explain the interface between the regula-

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[87] 49 CFR 176.18. The National Cargo Bureau is a nonprofit organization established in 1952 to perform vessel inspections. The directorship of the bureau is composed of government and industry representatives. See U.S. General Accounting Office, *Management Improvement Could Enhance Enforcement of Coast Guard Marine Safety Programs*, GAO/RCED-85-59 (Washington, DC: Aug. 15, 1985).

[88] The Intergovernmental Maritime Organization (IMO) created by a convention adopted by the United Nations Maritime Conference in Geneva in 1948, was the first regulatory body to adopt the U.N. standards. More than 100 countries are members of IMO.

[89] 49 CFR 171.12.

[90] 49 CFR 171.12 and 176.11. International Maritime Dangerous Goods (IMDG) regulations may not be applied to transport of certain explosives, radioactive materials, or materials that are hazardous under U.S. Department of Transportation regulations but are not covered by the IMDG Code.

[91] 49 CFR 172.102. The U.S. Department of Transportation noted that this optional table is included in the interest of providing consistency with the International Maritime Dangerous Goods Code and alerting persons about the international requirements.

[92] 45 F.R. 51645, Aug. 4, 1980.

Photo credit: Waste Age Magazine

Personnel wearing appropriate equipment sample hazardous wastes in drums before transferring the wastes to a tank truck.

tions of the two agencies.[93] Since then, amendments to RCRA have been passed extending the scope of the law to include more than 100,000 small generators of hazardous wastes. Given the complexity of DOT and EPA regulations, the potential for confusion and inappropriate use of containers for transport is immense. However, the 1981 guidance document has not been updated, and information distributed by EPA to small generators in 1985 did not cover DOT's transportation regulations.

The Toxic Substances Control Act (TSCA) provides EPA with broad authority to regulate chemical substances and mixtures whose manufacture, processing, distribution in commerce, use, or disposal may present an unreasonable risk of injury to health or the environment.[94] One regulatory option available to EPA is to require that such substances or mixtures be accompanied by clear and adequate warnings and instructions when they are distributed, used, or disposed.[95] However, EPA regulatory action under TSCA has been limited; regulations for polychlorinated biphenyls require special markings on containers, equipment, articles, and transport vehicles.[96]

In addition to the designation of hazardous substances, CERCLA (or Superfund) and the Clean Water Act authorize EPA and the Coast Guard to provide technical information and advice to emergency response personnel and to respond to severe transportation accidents (see chapter 5). Data on accidents involving hazardous substances and wastes are also collected by EPA (see chapter 2).

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[93] U.S. Environmental Protection Agency, *Hazardous Waste Transportation Interface—Guidance Manual*, prepared for the U.S. Department of Transportation, PB82-182361 (Springfield, VA: National Technical Information Service, November 1981).

[94] 15 U.S.C. 2601

[95] 15 U.S.C. 2605(a)(3).

[96] 40 CFR 761, Subpart C.

Nuclear Regulatory Commission

NRC regulates the receipt, possession, use, and transfer of byproduct, source, and special nuclear materials.[97] A Memorandum of Understanding between DOT and NRC identifies the responsibilities of each agency.[98] NRC sets standards for the design and performance of packages used to transport high-level radioactive materials and conducts inspections of its licensees. Other NRC regulations require advance notification to States of certain shipments and provide for physical security measures. DOT has regulatory authority over the design and performance of packages used to ship low-level radioactive materials and transportation operations for high-level materials including highway routing. Chapter 3 contains a detailed examination of the requirements for containers for transporting radioactive materials.

Occupational Health and Safety Administration

OSHA of the U.S. Department of Labor is responsible for safety and health in the workplace. However, the Occupational Safety and Health Act prohibits OSHA from acting where another Federal agency has already exercised its regulatory authority.[99] A Memorandum of Understanding between DOT and OSHA delineates those areas in which DOT has exercised its authority. Transportation presents two major regulatory areas of concern—vehicle operator safety and the protection of workers handling packages containing hazardous materials at shipping or transfer facilities. DOT has established requirements for vehicle operators, so OSHA has not taken any regulatory action. OSHA has generally accepted DOT's packaging rules, although there have been instances where packages meeting DOT transport requirements could not be handled in the workplace.[100]

OSHA also requires chemical manufacturers and importers to develop or obtain Material Safety Data Sheets (MSDSs) for hazardous substances and to label containers that are used in or leave the workplace in a manner that does not conflict with DOT regulations.[101] Although the contents of MSDSs vary, they can provide basic information about hazardous materials present in a State or locality; however, they rarely provide any transportation-related information.

Interstate Commerce Commission

The regulatory role of ICC has been limited since the establishment of DOT. ICC requires carriers of hazardous materials to publish rates.[102] In addition, ICC is required to investigate whether safe and adequate service, equipment, and facilities are provided by carriers subject to ICC jurisdiction.[103] Common and contract motor carriers of hazardous materials must obtain ICC operating authority, although safety ratings for certifications are provided by BMCS. The safety rating is based on a number of factors including violations over the past 5 years, discovered by BMCS during safety management audits, and driver equipment compliance reviews; the carrier's improvement or lack thereof during the same time period; and the carrier's accident record. While BMCS currently has information stored in a computerized database on more than 200,000 interstate carriers and 25,000 hazardous materials shippers, less than 15 percent of the entries contain sufficient information for providing initial safety ratings.

Department of Energy

Under the provisions of the Nuclear Waste Policy Act (NWPA) of 1982, DOE acquired responsibility for high-level nuclear waste movement, storage, and disposal. DOE will be responsible for moving the waste from utility reactor sites to a geologic repository, targeted for completion in 1998, or a monitored retrievable storage facility if one is approved by Congress. DOE is authorized by DOT to approve packaging and certain operational aspects of its own research, defense, and contractor shipments, provided that DOE complies with NRC standards and employs procedures equivalent to those of NRC in the container certification process.[104] In the past, DOE has often chosen to use procedures equivalent to but not identical to NRC regulations for its shipments; however, DOE has indicated that all NWPA shipments will be conducted in accordance with NRC and DOT regulations.[105] Chapter 3 provides more information on the NWPA shipments.

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[97] The Nuclear Regulatory Commission authority is derived from the Atomic Energy Act of 1954, 42 U.S.C. 2011.

[98] 44 F.R. 38690, July 2, 1979.

[99] 29 U.S.C. 653 (b)(1).

[100] See the Occupational Safety and Health Administration (OSHA) regulations for container and portable tank storage (29 CFR 1910.106(d)(2)). The OSHA regulations require use of U.S. Department of Transportation (DOT) approved metal containers and portable tanks for flammable or combustible liquids; these requirements were based on National Fire Protection Association (NFPA) standards. However, DOT permits the use of fiber and plastic containers for certain flammable materials. NFPA has amended their standards to conform to DOT regulations, but OSHA has not yet changed its regulation. However, industry has been advised that any approved DOT container is acceptable.

[101] 29 CFR 1910.1200. The Occupational Safety and Health Administration (OSHA) standard also requires employers in the manufacturing sector to develop written hazard communication programs to inform and train workers about hazardous substances. OSHA is considering the expansion of this standard to include employees in other industrial sectors.

[102] 49 U.S.C. 10702 and 10761.

[103] 49 U.S.C. 11101.

Department of Defense

DOD transports many hazardous materials. When government contractors or other commercial parties transport DOD materials, DOT and NRC regulations apply. Shipments undertaken by DOD itself, however, are subject to their own requirements, which are similar to those developed by DOT and NRC.[106] DOD requirements and operations were not reviewed for this study.

National Transportation Safety Board

NTSB was created in 1966 as an arm of the Department of Transportation. A 1975 legislative action made NTSB an independent agency that reports directly to Congress. NTSB has a hazardous materials branch that investigates accidents for all modes and determines the probable cause. In addition, NTSB has conducted studies on topics such as hazardous materials regulatory compliance, risk analysis, railroad yard safety, and hazard classification. Although NTSB is not a regulatory agency, its recommendations have influenced DOT programs.

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[104] 49 CFR 173.7.

[105] Memorandum of Understanding between the Research and Special Programs Administration of the U.S. Department of Transportation and the Office of Civilian Radioactive Waste Management of the U.S. Department of Energy for the Transportation of Radioactive Materials Under the Nuclear Waste Policy Act, September 1985.

[106] U.S. Department of Defense regulations are recognized by the Research and Special Programs Administration. See 49 CFR 173.7 and 177.806.

STATE AND LOCAL REGULATION

Evolution of State Programs

The entry of State governments into the field of hazardous materials transportation safety began in earnest in the early 1970s. A series of episodes involving radioactive materials prompted States to call for more vigorous efforts to monitor and control the shipment of hazardous materials. Since it was apparent that the resources committed by the Federal Government to police shipments of radioactive material—much less other, more common, forms of hazardous materials—were limited, the States began to seek ways to develop inspection and enforcement capabilities. The task was formidable since States then had virtually no organizational structure, legal authority, or personnel with specialized competence in the area of hazardous materials control.

In 1973, DOT and NRC's predecessor, the Atomic Energy Commission, undertook a program in cooperation with nine States to collect data on the amount and type of radioactive material originating in and passing through selected locations. This effort, known as the State Surveillance of Radioactive Materials Transportation (SSRMT) program, was directed at determining the magnitude of the problem posed by radioactive materials and the degree of regulatory noncompliance by shippers and carriers. The SSRMT study identified needed improvements in data collection, recordkeeping, and enforcement and pointed to the need to strengthen State-level prevention and enforcement mechanisms for all types of hazardous materials. SSRMT findings thus helped form the basis for a more substantial Federal program to aid in the development of State hazardous materials safety programs.

State Hazardous Materials Enforcement Development Program

Shortly after the SSRMT study was completed, responsibility for administering Federal-State cooperative programs was transferred to RSPA. Under RSPA, the programs were broadened to include all classes of hazardous materials, and emphasis shifted from data collection to regulatory enforcement, especially development of State organizations that could assume a greater share of inspection and enforcement functions.[107]

In 1981, RSPA initiated the State Hazardous Materials Enforcement Development (SHMED) program, designed to assist States in the enforcement of hazardous materials safety standards and regulations, primarily those pertaining to highway transportation. SHMED had two objectives: 1) decreasing the number of hazardous materials transportation accidents by strengthening State enforcement capabilities, and 2) promoting uniformity in State hazardous materials safety regulations and enforcement procedures. The SHMED program offered participating States contracts to conduct a three-phase program. The first phase, funded at a maximum of $20,000 per State, concentrated on data gathering, passage of enabling legislation, and adoption of Federal regulations. The second phase had a funding limit of $40,000 and required States to develop and implement an inspection program. In the third phase, with funding of up to $60,000, States had to establish enforcement procedures. In all, 25 States have participated in SHMED (see figure 4-6).

Compared to most Federal-State programs, SHMED is small. The 1984 budget was $1.1 million, and overall expenditures through 1986, when the program expires, will amount to just over $3 million. Nonetheless, it has had a significant influence in shaping State enforcement programs and in defining what constitutes an effective program. While some States, such as New Jersey, have established enforcement programs without SHMED support, the majority of existing State programs have had SHMED funding. Indeed, New Jersey enforcement officers participated in Maryland SHMED training programs.

Motor Carrier Safety Assistance Program

When the SHMED program ends this year, Federal support of State multimodal hazardous materials enforcement capabilities will diminish, and there will be no programs specifically targeted to hazardous materials transportation by rail, water, and air. However, Federal funds for State inspection and regulatory enforcement on the highways will be available through MCSAP, authorized under the Surface Transportation Assistance Act of 1982.[108]

The MCSAP grant program, administered by BMCS, is designed to improve State capabilities to enforce motor carrier safety regulations and to enable States to increase safety inspections of intrastate and interstate commercial vehicles in terminals and along roadsides. The development of an accurate database on compliance with safety regulations is a secondary goal of MCSAP, and funds may be used for data collection, storage, and analysis. The act specifically indicates that MCSAP may apply to enforcement of rules pertaining to vehicles used to transport hazardous commodities. Figure 4-7 shows the States participating in MCSAP.

Under MCSAP, States may apply for two types of grants. Development grants, available for a maximum of 3 years, provide funding for States needing to establish or substantially modify an enforcement program. Implementation grants provide funding for States ready to initiate or enhance established enforcement programs. To qualify for an implementation grant, a State must:

- agree to adopt and enforce the Federal Motor Carrier Safety Regulations (49 CFR 390-399) including highway-related portions of the Federal Hazardous Materials Regulations (49 CFR 171-173 and 177-178) or compatible State rules, regulations, standards, and orders applicable to motor carrier safety;
- submit an enforcement and safety program plan and designate a lead agency for administering the plan;
- agree to devote adequate resources to administration of the program and enforcement of rules, regulations, standards, and orders; and

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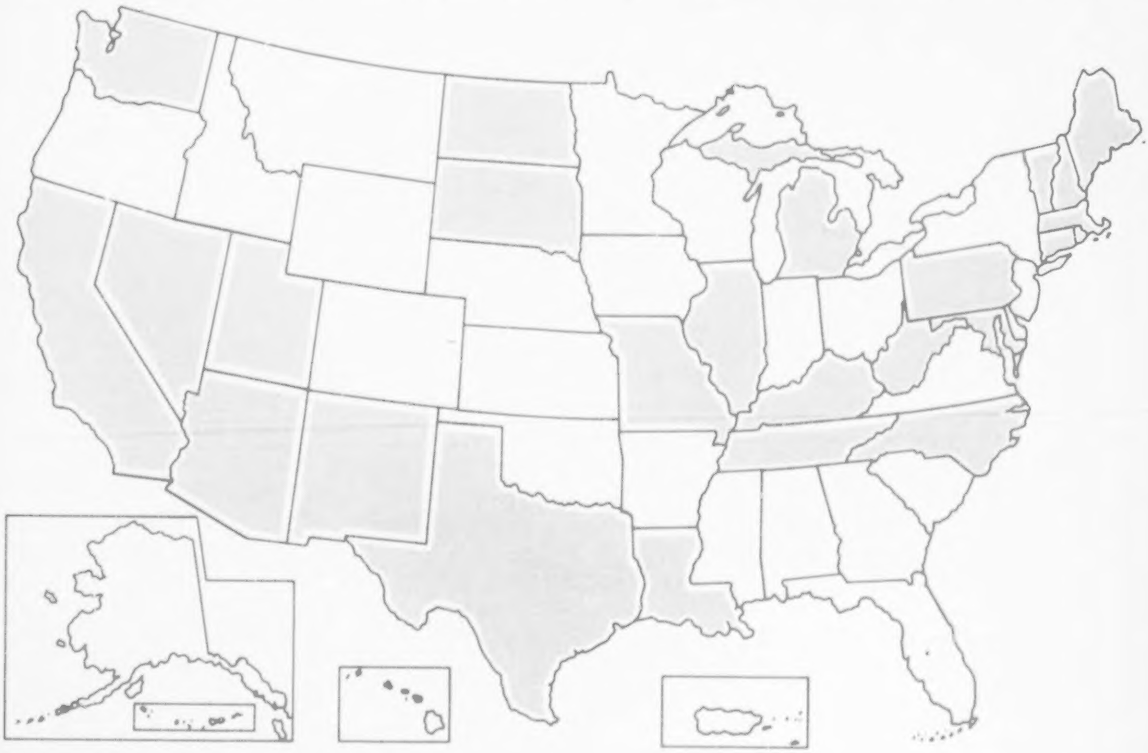
[107] Stephen N. Salomon, *State Surveillance of Radioactive Materials Transportation: Final Report*, NUREG-1015 (Washington, DC: U.S. Nuclear Regulatory Commission, Office of State Programs, 1984).

[108] Public Law 97-424. Motor Carrier Safety Assistance Program grant regulations are spelled out in 49 CFR 350.

Figure 4-6.—States Participating in the State Hazardous Materials Enforcement Development Program



Key:

States participating in the State Hazardous Materials Enforcement Development (SHMED) program. ▨

States not participating in the State Hazardous Materials Enforcement Development (SHMED) program. ☐

SOURCE: Office of Technology Assessment.

- have established statutory authority to regulate private and for-hire motor carriers and provide for right of entry into vehicles and facilities.

MCSAP is financed through the Highway Trust Fund under a 5-year authorization: $10 million was authorized for fiscal year 1984, and $10 million was to be added each year up to a maximum of $50 million by fiscal year 1988. The Federal grants were to be matched by States on an 80:20 basis. To date, actual appropriations have been significantly lower. The projected total amount of development and implementation grants under MCSAP is estimated to be $13 million for 1985; approximately $17.4 million is authorized for 1986.[109] However, the Secretary of Transportation has requested that the $50 million maximum funding level for MCSAP be authorized in fiscal year 1987.

State officials committed to expanding hazardous materials enforcement have expressed concern that MCSAP gives priority to general motor carrier safety programs and that hazardous materials enforcement activities—especially those for nonhighway modes—

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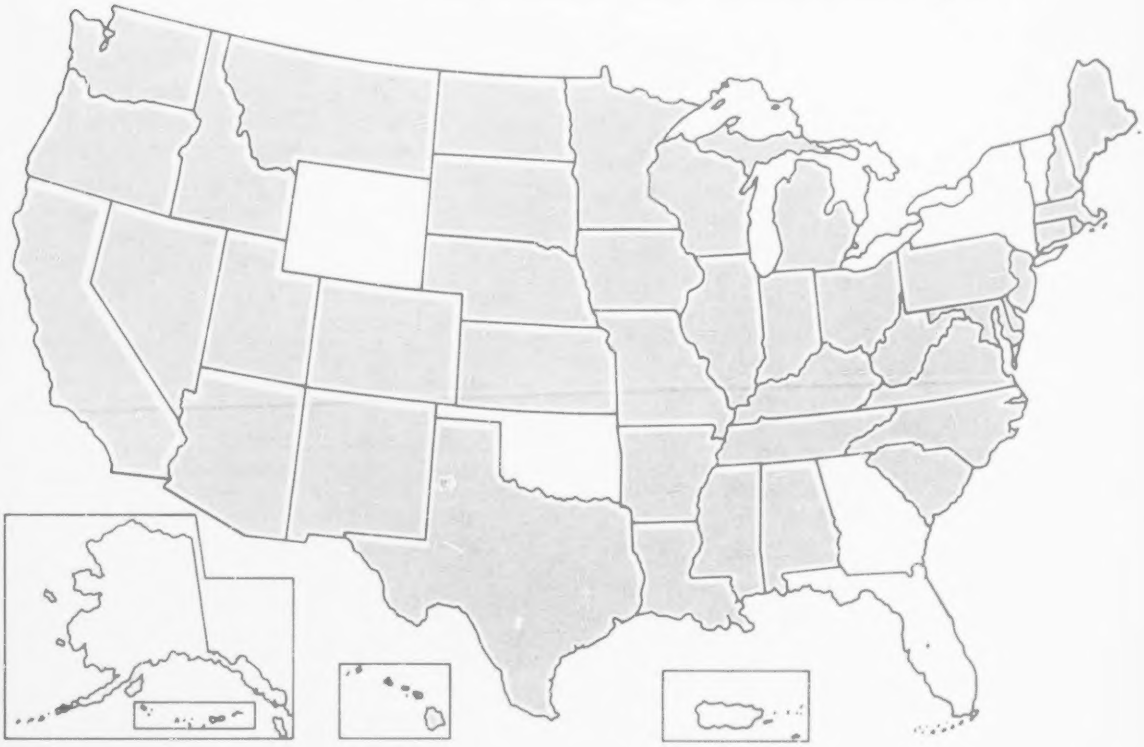
[109] Gary Curtis, Chief, Operations Division, Bureau of Motor Carrier Safety, personal communication, Feb. 13, 1986.

Figure 4-7.—States Participating in the Motor Carrier Safety Assistance Program



Key:

▨ States participating in the Motor Carrier Safety Assistance Program (MCSAP).

☐ States not participating in the Motor Carrier Safety Assistance Program (MCSAP).

SOURCE: Office of Technology Assessment.

are being slighted. Since MCSAP funds are restricted to highway safety purposes, the broader question arises of how States are to develop or improve inspection, regulation, and enforcement for other modes of transportation, because no similar Federal programs exist for water, rail, or air. Particular concern has been expressed by States with high concentrations of nonhighway hazardous materials shipments. In an effort to continue the work begun under the SHMED program, RSPA and BMCS recently sponsored four regional conferences, referred to as the Cooperative Hazardous Materials Enforcement Development Program, to help States promote uniform enforcement practices.

Commercial Vehicle Safety Alliance

In an initiative independent of the Federal Government, 26 States and the Canadian Provinces of Alberta and British Columbia have become members of the Commercial Vehicle Safety Alliance (CVSA), formed in 1980. Created under the leadership of California, Idaho, Oregon, and Washington, CVSA seeks to foster interstate cooperation in establishing uniform safety inspection standards for trucks. Under the terms of the alliance, members agree to use common inspection standards and out-of-service criteria and to honor the inspections of other jurisdictions. In this way, CVSA hopes to secure greater acceptance of motor carrier inspection programs by the trucking industry and to reduce delays caused by duplicative inspections of interstate truck shipments.

CVSA inspection standards and procedures have been developed in cooperation with BMCS and RSPA. The inspection process concentrates on the critical items (brakes, steering, tires, wheels, couplers, and suspension) most frequently identified as causes of truck accidents. In addition, the driver's qualifications and log book are checked. CVSA has recently added hazardous materials inspection standards and out-of-service criteria to its procedures. On passing inspection in a CVSA jurisdiction, the vehicle receives a decal valid for 3 months allowing it to travel through member States without further inspection unless a visible or audible defect is detected. Reciprocity, uniformity, and consistency are the key concepts of the alliance.

A CVSA associate membership program has recently been formed through which industry members serve in an advisory and nonvoting capacity to contribute their views, experience, and concerns. Since many of the States participating in CVSA are involved in SHMED and MCSAP as well, State agencies and personnel are developing a nationwide program of State-level hazardous materials transportation inspection and enforcement capability. The three organizations now hold joint national and regional meetings. CVSA sees its role as providing a link between Federal and State agencies responsible for motor carrier and hazardous materials inspection and enforcement.

Current State and Local Activities

A condition of State participation in MCSAP is passage of legislation adopting Federal motor carrier safety regulations and those portions of Federal hazardous materials regulations pertaining to highway shipments. MCSAP also requires States to conduct inspections of both intrastate and interstate motor carriers. As of August 1985, all but two States had adopted 49 CFR wholly or in part; however, legal processes allowing extension of 49 CFR to intrastate motor carriage have only just begun in many States.

Despite this strong encouragement for uniform regulations and enforcement policies, great regulatory variation remains from State to State. Familiarity with numerous State laws is thus a necessity for interstate carriers, and development of nationally standardized training is difficult. Some States exempt specific commodities, such as agricultural fertilizers; others exclude private carriers from regulation. In Illinois, hazardous materials regulations apply only to quantities that require placarding by Federal law, while in South Dakota, shipments of flammable and combustible liquids are exempt.[110] According to a 1985 survey of 47 States, 46 States indicated that they regulate common and contract carriers, while only 43 said that private carriers are regulated.[111] Moreover, the extent to which intrastate shipments of hazardous materials are regulated also varies. For example, some jurisdictions have established more stringent container requirements for intrastate transport, while in others, second- or third-hand cargo tanks that no longer meet Federal standards may be used.[112]

Restrictive State and local legislation is frequently passed in an attempt to regulate the transportation of hazardous materials perceived as posing a high risk to public safety. Many of these laws establish requirements in areas not presently covered by Federal regulations; others are enacted because State and local governments believe that existing Federal requirements are inadequate. A recent DOE report identified 513 State and local laws that affect the transportation of radioactive and other hazardous materials.[113] Moreover, faced with increasing responsibilities for the enforcement of hazardous materials regulations and emergency response activities and a general trend of decreasing Federal financial support, some State and local governments have turned to permit, licensing, and registration fees to help cover the costs of their programs. Unlike States, local governments do not receive Federal grants for enforcement programs and must rely on alternate sources of funding.

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[110] U.S. Department of Transportation, Materials Transportation Bureau, "State Hazardous Materials Enforcement Development (SHMED) Program Workshop Proceedings," unpublished typescript, 1983, pp. 121 and 183.

[111] U.S. Department of Transportation, Research and Special Programs Administration, "State Hazardous Materials Enforcement and Development (SHMED) Hazardous Materials Survey," unpublished typescript, Sept. 30, 1985.

[112] New York City regulations require the use of steel cargo tanks for shipments of flammable materials; Federal regulations permit the use of steel or aluminum. New York City Fire Department Directive 7-74, Mar. 23, 1984, and revisions. Ch. 3 contains additional information on cargo tanks.

[113] N.P. Knox, et al., *Transportation of Radioactive and Hazardous Materials: A Summary of State and Local Legislative Requirements for the Period Ending December 31, 1984*, ORNL/TM-9563 (Oak Ridge, TN: U.S. Department of Energy, September 1985). The types of requirements identified by the survey include transport approvals, conditional bans on transportation, documentation, escorts, Federal/State compliance, legal and financial requirements, notification, permits, placarding, transport prohibitions, routing restrictions, and vehicle specifications. Most State and local laws apply to highway and rail shipments; however, several address ports and one deals with air transport.

Bridge, tunnel, and turnpike authorities also establish regulations governing shipments of hazardous materials. The potential catastrophic consequences of an accident inside a tunnel or on a bridge underscore the need for safety precautions and emergency response planning. A recent survey conducted by the International Bridge, Tunnel, and Turnpike Association found that the three primary concerns of their U.S. members are: having appropriate incident response systems, obtaining information on movements of hazardous materials, and adequate indemnification including loss of revenue coverage.[114] Requirements imposed by transportation facilities often include prenotification, escorts, and prohibitions against shipments of certain materials such as flammable gases.

Licensing, Registration, and Permits

Licensing, registration, and permit requirements enable State and local governments to monitor and obtain information from shippers and carriers operating within their jurisdictions. The three terms—permit, license, and registration—are used to describe a variety of programs in different jurisdictions. However, a general distinction can be made between registration programs designed to identify shippers and carriers and permitting or licensing programs, usually intended to obtain assurances of fitness and more detailed information about company operations. Fees from such programs are often used to cover only the administrative costs of processing application forms; however, they are also used to generate funds for emergency response and enforcement activities.

State and local requirements vary; some focus on specific types of hazardous materials, while others are broader in scope. Information requested from shippers and carriers may include the types of materials they handle, origins and destinations of shipments, routes followed, miles covered in a given year, proof of insurance coverage, vehicle inspection dates, and drivers employed. There are also differences in the period of time covered by a permit and the fees levied. For example, 34 States require transport companies carrying hazardous wastes to register and pay a fee on a per vehicle or per company basis.[115] Fees imposed range from a low of $3 up to $500 and may be good for one trip only or for as long as a year. Some States also require special driver training or certification, vehicle registration and inspection, and proof of liability insurance. Table 4-7 summarizes State hazardous waste permit requirements.

Local jurisdictions may also require separate permits for carriers operating within their boundaries. Denver requires carriers of hazardous materials (except radioactive materials, and diesel and gasoline fuel in quantities under 111 gallons) to obtain annual permits by mail. Fees are assessed based on the number of trucks in a carrier's fleet; they range from $50 per year for a fleet of 1 or 2 trucks to $600 per year for 500 or more trucks. A description of the material to be transported (based on historical information), proof of liability insurance as required by Federal regulations (49 CFR 397.9), and acknowledgment of the routes designated by the city for hazardous materials shipments must be submitted. Funds generated are used to support the city's hazardous materials transportation enforcement activities and administration of the permit program.[116]

Data obtained through permit, licensing, or registration requirements may be used to target enforcement activities, plan emergency response programs, or develop regulations. For example, emergency response personnel would use data on the types of materials they are likely to encounter to develop

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[114] International Bridge, Tunnel, and Turnpike Association, "Hazardous Materials Transportation Survey Results," unpublished typescript, June 8, 1984.

[115] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, March 1986).

[116] Article VI of Chapter 22, Denver Municipal Code; and Tony Massaro, Office of Environmental Affairs, City and County of Denver, personal communication, Feb. 11, 1986

Table 4-7.—States with Proposed or Existing Hazardous Waste Transportation Registration and Fee Requirements*

State	Company registration	Company fee	Year covered	Vehicle registration	Vehicle fee	Vehicle inspection	Driver training certification/ registration
Alabama	Yes	$250	3 yrs				
Arizona	Yes						
Arkansas	Yes	$100/$50[a]	5 yrs				
California	Yes	$200	1 yr	Yes	$50 each[b]	Yes	Yes
Colorado	No						
Connecticut	Yes	$500[c]	1 yr	Yes		Yes	Yes
Delaware	Yes	$50	1 yr				
Florida	No						
Georgia	No[d]						
Idaho	Yes[e]	$20					
Illinois	Yes	$100	1 yr	Yes			
Indiana	Yes[f]	$100	1 yr	Yes	$10 each	Yes	
Iowa	No						
Kansas	Yes	$250	1 yr				
Kentucky	Yes	$25	1 yr	Yes			
Louisiana	No						
Maine	Yes	$100[g]	1 yr	Yes	Yes[g]		
Maryland	Yes		1 yr	Yes	$50/trailer		Yes[h]
Massachusetts	Yes	$100	1 yr	Yes	$200 each	Yes	Yes
Michigan	Yes[f]	$500	1 yr		$200 each		
Minnesota	No						
Mississippi	No						
Missouri	Yes		1 yr	Yes	$20/100[i]		
Montana	Yes	$25	1 yr		$5 each		
Nebraska	No						
Nevada	Yes[j]						
New Hampshire	Yes	$100	1 yr	Yes			Yes
New Jersey	Yes		1 yr	Yes	$50[k]		Yes
New Mexico	No						
New York	Yes[f]		1 yr	Yes	$500[l]		

*This table only covers State registration requirements and fees for hazardous waste transporters; requirements for radioactive materials and hazardous materials transport are not included.

[a] The Arkansas Department of Pollution registration fee is $100, while the Arkansas Transportation Commission fee is $50.

[b] A vehicle fee of $50, vehicle registration, and inspection is required for trailers (tractors are exempt), freight containers, and rail containers involved in hazardous waste transport. Intermodal tanks (>110 gallons) must also be inspected; the fee is $25.

[c] Transporters in Connecticut pay an initial registration fee of $500, the annual renewal fee is $350. Spill contractors transporting in Connecticut pay an initial registration fee of $600 and an annual renewal fee of $450.

[d] However, Georgia requires registration of for-hire carriers of LNG, PCBs, and radioactive wastes. A company fee of $100 or purchase of a $25 trip permit, good for one trip or 5 days, is required. Vehicle registration is also required.

[e] Requirement becomes effective on July 1, 1986.

[f] Applies to transporters of liquid industrial wastes.

[g] Registration fee covers one company location, one truck, and one driver; additional locations, trucks, or drivers are $50 each.

[h] Drivers are charged a fee of $20 and must receive State approved training.

[i] The vehicle fee varies from $20 to $100, depending on the number of vehicles and their weight.

[j] Applies to waste PCBs only.

[k] $50 per vehicle for the first 20 vehicles, $5 per vehicle for additional vehicles.

[l] Registration for a single vehicle is $500 plus a $25 processing fee; additional vehicles are registered for $200 with a processing fee of $5. Companies may not be required to pay more than $300 for processing and they have the option of paying an annual company registration fee of $5,000 instead of individual vehicle payments.

Table 4-7.—States with Proposed or Existing Hazardous Waste Transportation Registration and Fee Requirements, 1986—Continued

State	Company registration	Company fee	Year covered	Vehicle registration	Vehicle fee	Vehicle inspection	Driver training certification/ registration
North Carolina	Yes	$25	one time			Yes	
North Dakota	Yes						
Ohio	Yes	$25		Yes	$3 each		
Oklahoma	Yes		1 yr		$15 each		
Oregon	Yes	$125[m]	1 yr	Yes		Yes	
Pennsylvania	Yes	$125/200[n]	1 yr/2 yr				
Rhode Island	Yes		1 yr	Yes	$25 each	Yes	Yes
South Carolina	Yes						Yes
South Dakota	No						
Tennessee	Yes	$300[o]	1 yr				
Texas	Yes	$25	one time				
Utah	No						
Vermont	Yes		1 yr	Yes	$10/unit[p]		
Virginia	Yes	$80/120[q]	10 yrs				
Washington	No						
West Virginia	No						
Wisconsin	Yes[r]	$400	2 yrs				Yes
Wyoming	No						
District of Columbia	No						

[m] The $150 fee must be paid to obtain operating authority to haul hazardous wastes; this is not considered a registration fee.

[n] The Public Utilities Commission annual registration fee is $125 and the Department of Environmental Resources biannual fee is $200.

[o] Renewal fee is $200.

[p] Each vehicle unit is assessed a fee of $10; tractors and trailers are considered separate units.

[q] In-State companies pay $80, while out-of-State companies pay $120.

[r] Permit requirements apply to transporters of hazardous wastes, as well as solid wastes and PCBs.

SOURCE: American Trucking Association survey provided by Charles Mayer, Tri-State Motor Transit Co., updated by U.S. Congress, Office of Technology Assessment, May 1986.

appropriate training programs. Driver or carrier information is important to enforcement officials for identifying individuals or firms with poor performance records. Regulatory agencies interested in providing industry with information on new or amended regulations must know the location of shippers and carriers of hazardous materials. An example of a strong State program, described in box 4A, is California's licensing and computerized statewide database and information system.

Proliferation of State and local licensing, registration, and permit requirements, usually applicable to trucks, can pose hardships for carriers. Aside from the impact of a requirement within the regulating State, transporters are concerned about the cumulative economic impact of these requirements and particularly about permits or licenses that must be obtained per vehicle or per trip. The latter can increase transit time. One carrier noted that, in order to ensure that his driver was completely prepared to transport a load of hazardous wastes from Georgia to Wisconsin, he had to telephone every State along the route, sometimes calling as many as four or five agencies within a State, before he was fully apprised of all the requirements.[117] Many trucking company officials believe that adoption of special requirements by different States impedes interstate commerce and is inconsistent with the HMTA, and have taken legal action. These court cases are described later in this chapter.

Notification

Notification requirements have been established by numerous local governments; transportation facilities, such as bridge and tunnel authorities; and States. A study conducted by Battelle Memorial Institute for DOT identified 136 notification laws pertaining to hazardous materials transportation.[118]

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[117] Reported at the U.S. Congress, Office of Technology Assessment, Workshop on State and Local Activities, May 30, 1985.

[118] Battelle Columbus Laboratories, *Assessment of State and Local Notification Requirements for Transportation of Radioactive and Other Hazardous Materials* (Columbus, OH: Jan. 11, 1985).

Box 4A.—California's Licensing Program

California requires private and for-hire transporters of hazardous materials to pay a fee and obtain a license.* Each company must pay a $100 fee for the first year (there is a $75 renewal fee for subsequent years) and provide information on the number of trucks and trailers, commodities carried, and three emergency response contacts for work and nonwork hours to the California Highway Patrol. Licenses may be obtained by mail. As of February 1986, approximately 6,400 companies were licensed by California.[1] Monies collected are used to administer the program and support terminal hazardous materials inspections. Data on registrants allows the State to provide appropriate regulatory information to carriers such as routing restrictions for transporters of explosives, and has enabled the State to set up a computerized hazardous materials information system.**

The California information system, scheduled to be operational in mid-1986, consists of a profile of all carriers that currently carry hazardous materials or are likely to become involved in hazardous materials transportation in the State. In addition to licensing information, the profile includes data on inspection records, citations, and spills. Monthly reports will list all carriers with a hazardous materials license due to expire in 90 days. The reports will be sent to the carrier and to the California Highway Patrol along with a copy of each carrier's current profile. The database will also include a record of all highway hazardous materials incidents reported throughout the State. Monthly incident summaries will be issued by highway patrol subarea. The California system will have access to the information systems of the Bureau of Motor Carrier Safety and the Research and Special Programs Administration.[2]

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*Private transporters carrying hazardous materials in amounts subject to U.S. Department of Transportation placarding regulations must obtain a license. For-hire carriers hauling loads of 500 pounds or more of hazardous materials that requires placards in larger amounts, must also be licensed. Interstate and intrastate carriers are subject to these requirements.

**Emergency response contacts are requested because California offers carriers the option of responding to accidents themselves when they occur.

[1] Steve Brown, California Highway Patrol, Motor Carrier Division, personal communication, Feb. 13, 1986.

[2] California Highway Patrol, "SHMED Program System Objectives and Scope," unpublished typescript, 1984, p. 3.

The vast majority of these apply to trucks; a few apply to rail. Notification requirements, as defined by the study, include notification prior to shipments, periodic summaries, and reports on individual shipments filed after a trip. Prenotification is required by 23 State and 77 local regulations; 14 call for periodic reporting and 22 concern individual trip reports. Transportation facilities almost universally require some type of prenotification to arrange for escorts and notify emergency response agencies; these requirements focus on radioactive materials in addition to other hazardous materials, such as explosives and flammable materials. States and municipalities have tended to regulate spent fuel or high-level radioactive wastes, although some also include other radioactive materials. Table 4-8 lists State and local notification laws and the types of hazardous materials covered.

The Battelle study found that State and local governments typically give two reasons for enacting notification requirements: to provide data for planning (including better routing and safety regulations), and to improve emergency response. However, lack of enforcement of notification regulations means that there is little reason for shippers and carriers to comply, and several local agencies were found to be unaware of the notification laws they were supposed to enforce. Some community officials reported that they have never received a notification, even though it is required by local ordinance. The Battelle study observed that, while there are instances of conscientious enforcement and data collection, many local agencies charged with enforcing regulations on prenotification give the task relatively low priority. Often when information is collected, it is simply filed and not used for planning purposes.

Transporters are concerned that proliferation of State and local notification regulations creates scheduling difficulties and increases paperwork and staff needed to monitor requirements.

Hazardous Materials Driver's Licenses

A recent insurance industry publication indicates that one out every three tractor-trailers can be expected to crash in a year.[119] **While BMCS requirements for motor carrier drivers include written and road tests and a physical examination, the written test is used as an instructional tool only and a passing grade is not required.**[120] Although many States have established classified commercial licenses, drivers in 19 States are allowed to operate large trucks with a general commercial license, and driving a pick-up truck is very different from driving a large cargo tanker.[121] Moreover, it is common practice for many truck drivers, including those who handle hazardous materials, to possess driver's licenses from more than one State to avoid multiple violations in any given State. A 1980 investigation of drivers involved in large truck crashes by NTSB found that 44 drivers held 63 licenses, had 98 suspensions, were involved in 104 previous crashes, and had 456 traffic convictions.[122] In recognition of this situation, the American Trucking Association (ATA) has urged Congress and DOT to promote the implementation of a single license by all States so that truck drivers may hold licenses from their State of legal residence only. ATA has also recommended that applicants for a truck driver's license be given written examinations and road tests applicable to the type of vehicle that will be driven.[123]

Drivers transporting hazardous materials also should understand the special hazards associated with their cargo and the regulations governing such shipments. Data collected by DOT indicate that 62 percent of all accidents involving hazardous materials are the result of human errors.[124] This statistic underscores the importance of driver training as an accident prevention tool. Under HM-164, DOT requires drivers of vehicles carrying high-level radioactive waste to undergo training. Driver training re-

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[119] Insurance Institute for Highway Safety, "Big Trucks and Highway Safety," unpublished typescript, 1985, p. 1.

[120] 49 CFR 391.35(b).

[121] Insurance Institute for Highway Safety, op. cit., p. 3.

[122] National Transportation Safety Board, *Safety Effectiveness Evaluation of Detection and Control of Unsafe Interstate Commercial Drivers*, PB1980-162969 (Washington, DC: Feb. 15, 1980), pp. 18-20.

[123] Thomas Donohue, President and Chief Executive Officer, American Trucking Association, Statement Before the U.S. Senate, Committee on Commerce, Science and Transportation, Oct. 29, 1985. A new National Transportation Safety Board report also calls for a licensing system based on vehicle types. National Transportation Safety Board, "Training, Licensing, and Qualification Standards for Drivers of Heavy Trucks," NTSB/SS-86/02, unpublished typescript, spring 1986.

[124] Mark Abkowitz and George List, "Hazardous Materials Transportation: Commodity Flow and Information Systems," OTA contractor report, unpublished typescript, December 1985.

Table 4-8.—Commodities Covered by Notification Requirements, 1985

	Spent fuel and/or high-level waste	Other radioactive materials	Hazardous wastes	Other hazardous materials
State:				
Arkansas			X	X
California	X			
Colorado			X	
Connecticut	X	X		
Florida	X	X		
Georgia	X	X	X	X
Illinois			X	
Louisiana			X	
Maine		X	X	
Massachusetts	X		X	
Michigan	X	X		
Mississippi	X	X		
Nevada	X	X		
New Hampshire				X
New Jersey	X	X		
New Mexico	X	X		
North Carolina	X			
Ohio	X	X		
Oregon				X
Rhode Island	X	X	X	
South Carolina	X	X		
Tennessee	X			
Vermont	X	X		
Virginia	X	X	X	
Total	17	14	9	4
Local:				
Chickaswa, AL			X	
Phoenix, AZ			X	X
Tempe, AZ				X
Tucson, AZ	X	X		
Morro Bay, CA	X	X		
New London, CT	X	X		
Garden City, GA	B	X		
Lawrence, KS	B	X		
Covington, KY	X	X	X	X
Kenner, LA				X
Kent County, MD	X			
Prince George's County, MD	X	X		
Newton, MA	X			
Ypsilanti, MI	B	X		
Missouli, MT	X	X		
Binghamton, NY	X			
Geneva, NY	X	X		
Ithaca, NY	X	X		
Jefferson County, NY	X	X		X
New York, NY	X	X		
Rockland County, NY	X	X		
St. Lawrence County, NY	X	X		
Syracuse, NY	X	X		
Tompkins County, NY	X	X		
Vestal, NY	X	X		
Yates County, NY	X			
Facilities:				
Golden Gate Bridge, CA	X	X		
Delaware Memorial Bridge, DE	X	X	X	X
Francis Scott Key Bridge, MD	X	X		X
Harry W. Nice Memorial Bridge, MD	X	X		X
John F. Kennedy Memorial Highway, MD	X	X		X

Table 4-8.—Commodities Covered by Notification Requirements, 1985—Continued

	Spent fuel and/or high-level waste	Other radioactive materials	Hazardous wastes	Other hazardous materials
Susquehanna River Bridge, MD	X	X	....	X
William Preston Lane, Jr. Memorial Bridge, MD	X	X	....	X
Massachusetts Turnpike Authority, MA	X	X	....	....
Blue Water Bridge, MI	B	B	....	X
Mackinac Bridge, MI	X	X	....	X
Garden State Parkway, NJ	X	X	....	....
Newark International Airport, NJ	X	X	....	X
New Jersey Turnpike, NJ	X	X	....	X
Bayonne Bridge, NY	X	X	....	X
George Washington Bridge:				
Expressway, NY	B	X	....	....
Lower Level, NY	B	X	....	....
Upper Level, NY	X	X	....	X
Geothals Bridge, NY	X	X	....	X
Holland Tunnel, NY	B	X	....	....
Kennedy International Airport, NY	X	X	....	X
La Guardia Airport, NY	X	X	....	X
Lincoln Tunnel, NY	B	X	....	....

NOTE: X= existing; B= bans on transportation.

SOURCE: Battelle Human Affairs Research Center.

quirements have also been established by DOT for carriers of flammable cryogenic liquids. One carrier specializing in radioactive materials transport indicated to OTA that drivers employed by his firm who haul hazardous materials have better safety records than other drivers.[125] Some carrier associations, insurance industry representatives, State motor vehicle administrators and enforcement personnel, and the National Hazardous Materials Transportation Advisory Committee have voiced strong support for a national **hazardous materials** driver's license requiring special training and testing. Driver training would emphasize how to handle hazardous materials and respond to accidents. In addition, some large shippers and a few carriers have established special training courses for their drivers; examples of these programs are described in chapter 3.

Several States have already established special certification requirements for drivers of vehicles used to transport hazardous wastes. (See table 4-7.) California recently passed legislation requiring special certification for drivers of vehicles hauling hazardous materials, including hazardous wastes.[126] Certification requirements include a medical examination and a written test on applicable Federal and State laws and regulations for the transportation of hazardous materials and safe driving practices. A certificate of training issued by an employer of a driver may be submitted in lieu of the written test. The California Highway Patrol and the Department of Motor Vehicles are presently developing training regulations for drivers.

In addition to driver training and licensing, there is also a need for improved access to information on driver and carrier performance on a nationwide basis. While existing Federal databases, described in chapter 2, record data on violations and accidents, they would be more useful if they were interfaced and made accessible to State enforcement personnel. The SAFETYNET Program, being developed by FHWA, and the National Driver's Registry, being developed by the National Highway Traffic Safety Administration, will help, but their full implementation is at least a decade away.

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[125] Charles Mayer, Vice President, Nuclear and Hazardous Materials Division, Tri-State Motor Transit Co., in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Transportation of Hazardous Materials Advisory Panel Meeting," unpublished typescript, Jan. 31, 1986.

[126] California Senate Bill No. 895, ch. 667, Statutes of 1984. Amendments to the California law are presently under consideration.

Routing Requirements

Routing is an important tool for local governments for preventing or reducing the consequences of hazardous materials accidents, and increasing numbers of cities, counties, and townships are adopting ordinances requiring hazardous materials carriers to use designated routes. Carefully made routing decisions restrict hazardous materials shipments to the safest routes, often Interstate highways and beltways, providing a low cost prevention measure that local police can enforce without additional equipment or training. On the other hand, routing requirements may lengthen and complicate trips for truckers, and sometimes bring local governments into conflict with each other or with Federal regulations governing interstate commerce. The trucking industry has challenged some local routing ordinances, claiming that they interfere with interstate commerce (see discussion below).

Two Federal regulations pertaining to the routing of hazardous materials were described earlier in this chapter. The first is a general statement directing drivers of vehicles carrying nonradioactive hazardous materials to use routes avoiding heavily populated areas and tunnels, narrow streets, or alleys.[127] The second regulation, referred to as DOT Docket HM-164, applies to shipments of radioactive materials. The first part of the regulation requires carriers of all radioactive materials to operate on routes that minimize radiological risk. The second part applies only to highway route controlled quantities of radioactive materials, such as spent nuclear fuel; it requires the use of Interstate highways and beltways or State-designated alternate routes.[128]

To assist States and communities with the designation of routes for both radioactive and nonradioactive shipments of hazardous materials, DOT published two guidance documents. Both publications underscore the importance of involving a broad spectrum of community and industry members and neighboring jurisdictions in the route selection process. This approach encourages States and localities to: tap the knowledge and resources of persons and organizations experienced in the transportation of hazardous materials, identify the scope and objectives of a routing assessment at the outset, and determine whether and how to weight subjective factors in the routing analysis. It also provides a forum for addressing related safety issues such as vehicle inspections and emergency response capabilities. A 1983 demonstration program in Portland, Oregon, which successfully tested the DOT guidelines for nonradioactive materials, concluded that participation by all affected parties early in the planning process increases the likelihood of consensus as to which routes are safest.[129] See chapter 2 for a description of data-collection activities related to routing assessments.

Nonradioactive Materials.—The nonradioactive materials guidelines include procedures for analyzing risks associated with the use of alternative routes within a jurisdiction.[130] The risk assessment is based on the probability of a hazardous materials accident and the consequences of such an accident measured in terms of the population and/or property located inside the potential accident impact zone.[131] Other

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[127] 49 CFR 397.9(a). In 1977, the Bureau of Motor Carrier Safety provided an interpretation of this provision stating:

> Section 397.9(a) is not meant to preclude the use of expressways or major thoroughfares to make deliveries within a populated area. In many instances, a more circuitous route may present greater hazards due to increased exposure. However, in those situations where a vehicle is passing through a populated or congested area, use of a beltway or other bypass could be considered the appropriate route, regardless of the additional economic burden.

42 F.R. 60088, Nov. 23, 1977.

[128] 49 CFR 177.825. Highway route controlled quantities are defined in 49 CFR 173.403(l).

[129] City of Portland, Oregon, Office of Emergency Management, *Hazardous Materials Highway Routing Study* (Washington, DC: U.S. Department of Transportation, 1984), p. 48. The Portland experience is summarized in U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, op. cit., pp. 34-35.

[130] E.J. Barber and L.K. Hildebrand, Peat, Marwick, Mitchell, & Co., *Guidelines for Applying Criteria To Designate Routes for Transporting Hazardous Materials*, Implementation Package FHWA-IP-80-20 (Washington, DC: U.S. Department of Transportation, 1980).

[131] In 1985, the Ohio-Kentucky-Indiana (OKI) Regional Council of Governments discovered an error in the calculation of the population consequence factor. The U.S. Department of Transportation (DOT) acknowledged the error ("population density" for a route segment should have been used instead of "population"), noting that it does distort route analysis and that it only becomes apparent when route segment lengths are extremely disparate. S.C. Chu, DOT, Research and Special Programs Administration, letter to A.H. Hessling, Executive Director, OKI Council of Governments, May 3, 1985. Another recent application of the DOT guidelines in Dallas-Fort Worth recognized this error and took into account the length of each link or route segment in the estimation of the impact area. Dan Kessler, "Establishing Hazardous Materials Truck Routes for Shipments Through the Dallas-Fort Worth Area," in Transportation Research Board, "Proceedings From the Conference on Recent Advances in Hazardous Materials Transportation Research: An International Exchange," unpublished typescript, Nov. 10-13, 1985, pp. 443-464.

U.S. Refuses to Forbid Trucking Atomic Waste Through New York

SECOND AMENDMENT

BILL NO. 85-34

Ordinance No. 3190

AN ORDINANCE RELATING TO THE TRANSPORTATION OF HAZARDOUS MATERIALS AMENDING TITLE 9 OF THE MUNICIPAL CODE OF THE CITY OF LAS VEGAS, NEVADA, 1983 EDITION, BY ADDING THERETO A NEW CHAPTER, DESIGNATED AS CHAPTER 36; PRESCRIBING REGULATIONS TO GOVERN CONDITIONS RELATING TO THE TRANSPORTATION OF HAZARDOUS MATERIALS WHICH ARE HAZARDOUS TO LIFE AND SAFETY; RESTRICTING THE AREAS FOR TRANSPORTING HAZARDOUS MATERIALS WITHIN THE CITY; AUTHORIZING THE DEPARTMENT OF FIRE SERVICES TO OVERSEE ALL ACTIVITIES RELATING TO THE TRANSPORTATION OF HAZARDOUS MATERIALS AND DEFINING THE POWERS AND DUTIES THEREOF; PROVIDING FOR OTHER MATTERS PROPERLY RELATING THERETO; PROVIDING PENALTIES FOR THE VIOLATION THEREOF; AND REPEALING ALL ORDINANCES AND PARTS OF ORDINANCES IN CONFLICT HEREWITH.

Sponsored by:

Summary: Regulates and restricts the transportation of hazardous materials within the City of Las Vegas

Research and Special Programs Administration

DOT/RSPA/MTB 84/22

Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials

Thursday, October 11, 1984 THE CINCINNATI ENQUIRER METRO H-3

Suburban Officials Leery Of Study On Routes For Hazardous Cargoes

BY BEN L. KAUFMAN

An assessment of risks involved in trucking hazardous materials through the Tristate began Wednesday with questions and skepticism.

Cincinnati needs to know the relative safety of expressways through the Tristate and wants routes recommended for trucks carrying the hazardous material.

Suburban and township officials know that rerouting will probably involve use of Interstate 275 and more risk to their communities.

OHIO LAW requires dangerous cargoes be hauled over routes with the lowest risks to people and property, regardless of inconvenience to the shipper or carrier.

The six-month study is being done by the Ohio-Kentucky-Indiana Regional Council of Governments (OKI).

Cincinnati City Manager Sylvester Murray asked for the study under pressure from federal officials who objected to Cincinnati police enforcing the Ohio law by tagging truckers hauling hazardous material down I-75 instead going around the urban area on I-275.

To get things moving, OKI invited more than 120 public offi-

'Does anybody in

going to come to

Few hands went

that we're

-275?'

have been, given their ignorance of the risks and precautions they didn't take.

They would have been justified in ordering evacuation of everyone with half a mile of the accident, specialists say the half-mile the maximum exposure in a hazardous

FHWA-IP-80-15

IMPLEMENTATION PACKAGE

Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials

U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration

Photo credit: Office of Technology Assessment

Routing of hazardous materials has been a controversial issue in many localities.

factors, such as emergency response capabilities, and proximity to sensitive ecological areas or populations that may be unable to evacuate themselves, may be applied when a risk analysis does not indicate that one alternative is clearly superior to the others. The guidelines suggest that such factors be selected by consensus, reflecting community priorities.

A number of cities including Columbus, Denver, and Boston, have established hazardous materials routing restrictions based on the general routing provision of the Motor Carrier Safety Regulations.[132] The types of regulations enacted by these jurisdictions include: restricting the use of certain roads, prohibiting transportation and delivery during rush hours, and specifying operating requirements.

However, reaching a regional consensus on routing is frequently difficult, even when a broad community spectrum is consulted. Often, for example, after a community routing risk assessment has been completed, hazardous materials carriers are diverted from central city routes onto surrounding roadways—usually Interstate highways—that traverse less populated areas. Since many suburban communities do not have specialized hazardous materials response teams like their urban neighbors, they feel particularly vulnerable to increased hazardous materials traffic and resist agreeing to such routing requirements.

Since 1985, suburban townships in the Cincinnati region have opposed the city's efforts to divert through shipments from the Interstate highways passing through the city onto outlying highways. In contrast, Portland, Oregon, and neighboring jurisdictions succeeded in establishing a regional routing plan. The city enacted an ordinance banning hazardous materials shipments from a tunnel that had been used frequently by trucks carrying petroleum products from the city to other parts of the State because fire officials determined that the tunnel posed an unacceptably high risk. (Portland also banned shipments from two grade-level rail crossings.) To compensate for any additional risks posed by the rerouting decisions, the city of Portland and three adjoining counties revised their mutual aid agreements to ensure that the affected counties would have access to the city's specialized firefighting equipment.

Selecting routes within an urban jurisdiction may also be difficult. In Dallas-Fort Worth, a regional routing assessment based on the DOT guidelines found that the safest route through Dallas is the Interstate. However, a Dallas ordinance enacted in 1978 prohibits local hazardous materials vehicles from using the elevated or depressed portions of the Interstate, diverting shipments onto city arterials. City, State, and regional officials are currently working together to resolve this conflict; options under consideration include restricting the times when the Interstate and city arterials can be used for transporting hazardous materials and upgrading sections of the Interstate highway.[133]

Radioactive Materials.—The procedures established by DOT for State officials interested in designating alternate routes for radioactive shipments under HM-164 are somewhat different.[134] The objective of the route selection methodology presented in the guidance document for radioactive materials is to determine the route within a State to minimize the radiological impacts. Routing agencies in neighboring States are advised to work together, as selected routes in each State must match preferred routes in bordering States. The guidelines suggest the formation of interstate or regional coalitions for the selection of routes and note that States might also enter into agreements designating, as portions of preferred routes, ferry routes for the transport of motor vehicles on waters within their jurisdictions.

The methodology is based on the use of comparative risk index figures, not actual risk figures. The primary route selection factors identified by DOT are the levels of radiation exposure from normal transport, and the public health and economic (decontamination costs) risks associated with the accidental release of radioactive materials. Public health risks are determined by the frequency of severe transportation accidents and the number of people that could be affected by a release. A method for determining the population within a potential impact area is suggested. Secondary factors may be used if a clear-cut choice does not emerge from evaluation of the primary factors or if unusual conditions exist in the State that increase the importance of one or more of the secondary factors.[135] These factors include emergency response and evacuation capabilities, the location of special facilities, and traffic fatality and injury rates. Procedures for comparing secondary factors based on the use of arbitrary scaling systems are also provided.

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[132] See, e.g., Columbus Codes, 1959, Chapter 2551: Article VI of Chapter 22 of the Denver Municipal Code; and 46 F.R. 18921, Mar. 26, 1981, for a description of Boston's regulations. The Boston regulations have been challenged by the State and national trucking associations; the lawsuit is discussed later in this chapter.

[133] Dan Kessler, North Central Texas Council of Governments, Arlington, TX, personal communication, Mar. 11, 1986.

[134] U.S. Department of Transportation, Research and Special Programs Administration, *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials*, DOT/RSPA/MTB-84/22 (Washington, DC: June 1984 (originally published in June 1981)).

The guidelines have been used independently by New York City and Connecticut to evaluate the safety of shipping spent nuclear fuel from Long Island on routes through the city and through Connecticut using a ferry to cross Long Island Sound. The New York City case, described in box 4B, provides an example of the difficulties that can be encountered when routing decisions are made without interjurisdictional consultation.

Other State and Local Regulatory Activities

A number of States and localities have passed two other types of laws concerning their ability to collect data and protect emergency responders from liability.

Right-To-Know Laws.—Many States and municipalities have passed legislation, commonly referred to as "right-to-know" laws, requiring the release of information on the hazards associated with chemicals produced or used in a given facility. (Chapter 2 discusses fixed facility inventories that have been conducted by communities.) These laws have been adopted because some manufacturers have been unwilling to comply with requests for information due to concerns about protecting trade secrets or other information considered to be proprietary.

The majority of State right-to-know laws address both community and employee access to information about workplace hazards. Table 4-9 lists the States that have passed such laws. The provisions

Table 4-9.—State Right-to-Know Laws, 1985

State	Community provisions	Worker provisions
Alabama	...	X
Alaska	...	X
Arizona	...	...
Arkansas	...	X
California	...	X
Colorado	...	...
Connecticut	X	X
Delaware	X	X
Florida	X	X
Georgia	...	...
Hawaii	...	...
Idaho	...	...
Illinois	X	X
Indiana	...	...
Iowa	X	X
Kansas	...	...
Kentucky	...	...
Louisiana	X	X
Maine	X	X
Maryland	X	X
Massachusetts	X	X
Michigan	...	X
Minnesota	...	X
Mississippi	...	...
Missouri	X	...
Montana	X	X
Nebraska	...	...
Nevada	...	...
New Hampshire	X	X
New Jersey	X	X
New Mexico	...	...
New York[a]	...	X
North Carolina	X	X
North Dakota	X	X
Ohio	...	...
Oklahoma	...	...
Oregon	X	X
Pennsylvania	X	X
Rhode Island	X	X
South Carolina	...	...
South Dakota	...	...
Tennessee	X	X
Texas	X	X
Utah	...	...
Vermont	X	X
Virginia	...	...
Washington	X	X
West Virginia	X	X
Wisconsin	...	X
Wyoming	...	...

[a] Although New York has not passed community right-to-know regulations, in December 1983, Governor Cuomo issued an executive order requiring the Department of Environmental Conservation to inventory all toxic chemicals used, stored, or disposed of in the State.

SOURCES: National Conference of State Legislatures, "State Hazardous Materials Policy: Issues Raised by the Bhopal Incident," *State Legislative Report*, vol. 10, No. 1, January 1985; personal communication with Janis Adkins (ed.), *Right-To-Know News* (Washington, DC: Thompson Publishing Group, Oct. 22, 1985); and Department of Occupational Safety, Health, and Social Security of AFL-CIO, list of State right-to-know laws.

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[135] Ibid, p. 7.

Box 4B.—The New York City Case

The first inconsistency ruling was issued in 1978 and concerned an ordinance enacted by New York City that effectively banned the transport of commercial shipments of radioactive materials through the city. The issue arose because shipments of spent nuclear fuel from Brookhaven National Laboratory, located at Upton, Long Island, were passing through the city enroute to a reprocessing facility. The ordinance was found to be consistent by the U.S. Department of Transportation (DOT) because there was no identifiable requirement in the Hazardous Materials Transportation Act (HMTA) or the regulations providing a basis for a finding of inconsistency. However, DOT indicated that it intended to examine the need for Federal routing regulations. On January 19, 1981, DOT promulgated highway routing regulations for high-level radioactive materials, Docket HM-164. HM-164 prescribes the use of Interstate highways or State-designated routes, requires driver training, provides criteria for determining if a State or local routing rule is inconsistent, and lists related State and local requirements likely to be found inconsistent by DOT.

New York City filed suit against DOT on March 25, 1981, in Federal District Court regarding the validity of HM-164. The lawsuit alleged that HM-164 violated States rights, did not comply with the National Environmental Policy Act (NEPA), and did not maximize public safety. The District Court ruled that although HM-164 was procedurally within the scope of DOT's authority, it violated the HMTA and NEPA as it did not address the problems posed by low-probability, high-consequence accidents. Moreover, the District Court held that the HMTA required DOT to compare the relative safety of different modes of transport.[1] Thus, since HM-164 only considered the highway mode, DOT had not fulfilled the mandate of the HMTA. The case was appealed by DOT to the U.S. Court of Appeals for the Second Circuit where the judgment of the lower court was reversed. The Court of Appeals ruled that DOT is not required to maximize public safety on a jurisdiction-by-jurisdiction basis, but rather must provide an adequate level of safety on a nationwide basis. In addition, the Court of Appeals found that DOT complied with NEPA and that a comparison of different modes of transportation was not required.[2] The city and State of New York appealed to the U.S. Supreme Court, but the Court declined to hear the case.[3]

On December 24, 1984, New York City filed an amended application with DOT requesting a waiver of the preemptive effects of HM-164 on its routing restrictions for irradiated or spent fuel.* To support its application, New York City asked a private consulting firm to conduct a formal risk analysis based on the DOT routing guidelines for radioactive materials.[4] This analysis indicated that a route via highway and ferry through Connecticut posed a lower risk than a route passing through the city. Subsequently, Connecticut hired another consulting firm to review the analysis prepared for New York City.[5] Based on their consultant's report, Connecticut submitted comments to DOT alleging that the city had miscalculated the risk associated with the alternate routes and therefore failed to demonstrate that its regulation afforded an equal or greater level of protection than HM-164. In addition, Connecticut argued that the city's restriction on shipments of spent nuclear fuel unreasonably burdened commerce.[6]

Following the public comment period, DOT issued a decision, the first nonpreemption determination under Section 112(b) of the HMTA, denying the city's request for a waiver. DOT's determination was based on a finding that the city failed to show that HM-164 does not provide an adequate level of safety because of unique physical conditions. Absent a showing of "exceptional circumstances," DOT would not consider whether the city's ordinance afforded an equal or greater level of public safety or unreasonably burdened commerce, the two criteria specified in Section 112(b) of the HMTA. Moreover, DOT found that the establishment of alternate routes (e.g., routes other than preferred routes specified in HM-164) is the responsibility of a State routing

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[1] *City of New York v. U.S. Department of Transportation*, 539 F. Supp. 1237 (S.D.N.Y., 1982).

[2] *City of New York v. U.S. Department of Transportation*, 715 F.2d 732 (1983).

[3] 104 S. Ct. 1403 (1984).

*Although the New York City ordinance applies to five categories of radioactive materials, the preemption waiver application addressed only spent fuel.

[4] Arthur D. Little, Inc., "Irradiated Fuel Shipping Alternatives Through or Around New York City," unpublished typescript, Dec. 18, 1984.

[5] Energy Research Group, Inc., "Review of the New York City Request for a Non-Preemption Determination in the Matter of Spent Nuclear Fuel Transport," unpublished typescript, Mar. 20, 1985.

[6] Joseph I. Lieberman, Attorney General, State of Connecticut, "Comments by the State of Connecticut," Docket No. NPDA-2, Apr. 8, 1985.

agency.[7] New York City subsequently filed an administrative appeal with DOT. The city's appeal contends that no basis exists for the finding that a demonstration of exceptional circumstances is a necessary precondition for a nonpreemption determination; that the city does not have recourse to a State routing agency because all alternate routes go through Connecticut, which has opposed the designation of alternate routes; that DOT erred in failing to consider the city's safety analysis; and that the ruling was inconsistent with prior statements made by DOT.[8] DOT has requested public comments on the city's appeal.

New York City has also indicated that it believes that existing statutory and regulatory procedures to resolve interjurisdictional conflicts are time-consuming and inadequate. The city urges that an amendment to the HMTA divesting DOT of its authority to issue nonpreemption determinations be considered by Congress.[9]

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[7] 50 F.R. 37308, Sept. 12, 1985.

[8] 50 F.R. 47321-22, Nov. 15, 1985.

[9] Harvey W. Shultz, Commissioner, City of New York, Department of Environmental Protection, personal communication by letter, Apr. 30, 1986. Members of the New York State Congressional Delegation have introduced bills in the 99th Congress that would restrict the transportation of high-level radioactive materials through densely populated metropolitan areas. See H.R. 1105, introduced by Representative Mario Biaggi on Feb. 19, 1985, and H.R. 2938 introduced by Representative Bill Green on July 9, 1985.

of these laws are not uniform, either in terms of the obligations placed on industry or in terms of the types of hazardous materials covered. States have also taken different approaches to exemptions according to business size or quantities of material involved and the extent to which firms may protect trade secrets. Increasing numbers of local governments are also enacting their own right-to-know statutes.

The requirements of right-to-know laws most relevant to hazardous materials planning and emergency response include providing public access to information on hazardous materials present in a locality or State, conducting inventories or surveys, establishing recordkeeping and exposure reporting systems, and complying with container labeling regulations for workplaces. As described earlier in this chapter, OSHA now requires chemical manufacturers and importers to prepare MSDSs for all hazardous materials produced or used. Some States and localities specifically require that copies of MSDSs be made available to a State agency or local fire chief as part of their community right-to-know programs.

Good Samaritan Laws.—Governmental entities and industry are concerned that they may be held responsible for emergency response activities that result in damages. Good Samaritan laws have been enacted by at least 38 States to relieve the burden of potential liability for persons who assist during a hazardous materials transportation accident.[136] While most of these laws exclude gross negligence or willful misconduct, many States have limited the scope of liability protection in other ways. These differences are significant as they may affect whether and how emergency assistance is provided in a given State.

Some laws specify that emergency response personnel who have received a certain level of training are not relieved from liability. Consequently, members of specially trained hazardous materials response teams may not be covered by certain Good Samaritan laws. In contrast, a number of statutes provide immunity to individuals possessing certain qualifications such as training or education. Furthermore, some laws require that unless assistance is requested by a State or local official, persons who provide emergency assistance may not be extended immunity from liability. Additional differences in these laws include the types of hazardous materials addressed (for instance, some are restricted to compressed gases) and whether compensation is provided to emergency responders.

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[136] See National Conference of State Legislatures, *Hazardous Materials Transportation—A Legislator's Guide* (Washington, DC: February 1984), pp. 84-85 and app. F. Additional information was obtained from a report on State Good Samaritan Statutes, prepared by Lawrence W. Bierlein for the Chemical Manufacturers Association, Sept. 30, 1985.

Regulatory Consistency

States and localities, responding to what they find to be limitations of the Federal regulatory program, have enacted their own laws and regulations. Interstate shippers and carriers, reacting to what they feel are unreasonable burdens on interstate commerce, have asked Federal courts to preempt some of these State and local requirements. DOT's efforts to resolve interjurisdictional conflicts have been focused on case-by-case advisory rulings that determine whether State and local requirements are consistent with the HMTA and the hazardous materials transportation regulations.

Preemption Under the HMTA

While Congress granted DOT a broad mandate to regulate the transportation of hazardous materials, a regulatory role for State and local governments is preserved by Section 112 of the HMTA, in deference to their inherent powers to enact legislation to protect the health, safety, and general welfare of the public. However, the legislative history of Section 112, although limited, indicates that Congress intended to "preclude a multiplicity of State and local regulations and the potential for varying as well as conflicting regulations in the area of hazardous materials transportation."[137] Thus, while Section 112(a) preempts State or local requirements that are inconsistent with the HMTA requirements or regulations issued under it, Section 112(b) provides that an otherwise inconsistent State and local requirement may not be preempted if DOT determines that it affords an equal or greater level of protection to the public than Federal requirements and does not unreasonably burden commerce.[138] The latter provision was included because Congress also realized that certain exceptional circumstances might warrant more stringent State or local regulation.

Although the HMTA explicitly authorizes DOT to issue preemption waivers under Section 112(b), a similar delegation of authority is not made for deciding inconsistency questions under Section 112(a). To provide a forum for resolving interjurisdictional conflicts under the HMTA, DOT established procedures in 1976 allowing States, localities, affected parties, and DOT itself to initiate an administrative ruling process to determine whether State or local requirements are inconsistent.[139] This administrative process is advisory only and does not preclude judicial review of a State or local requirement. Independent of the DOT procedures, a Federal court may be asked to decide whether a State or local requirement is inconsistent and therefore preempted under the HMTA or is invalid under the Commerce Clause of the U.S. Constitution.

The standards applied by DOT in determining if a State or local requirement is inconsistent are the same as those used by the courts in preemption cases:

- whether compliance with both the State or local requirement and the HMTA is possible (the dual compliance or direct conflict test), and
- the extent to which the State or local requirement is an obstacle to the accomplishment and execution of the act and regulations issued under it (the obstacle test).[140]

The latter test is applicable irrespective of whether a direct conflict exists. The steps that must be followed to obtain an inconsistency ruling are specified in figure 4-8.

DOT has indicated that there are "strong policy reasons" for an administrative review; the process provides an opportunity to conduct a broader inquiry than one typically undertaken by a court, and it allows for diverse comments because notices are published in the *Federal Register*.[141] A finding of inconsistency under the DOT review process can also serve as the basis for an application for a waiver of preemption.

A waiver of preemption can be granted for an inconsistent State or local requirement under the HMTA if DOT finds that it affords an equal or greater level of protection to the public than Fed-

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[137] U.S. Senate, Report No. 93-1192, 93d Cong., 2d sess., 1974, pp. 37-38.

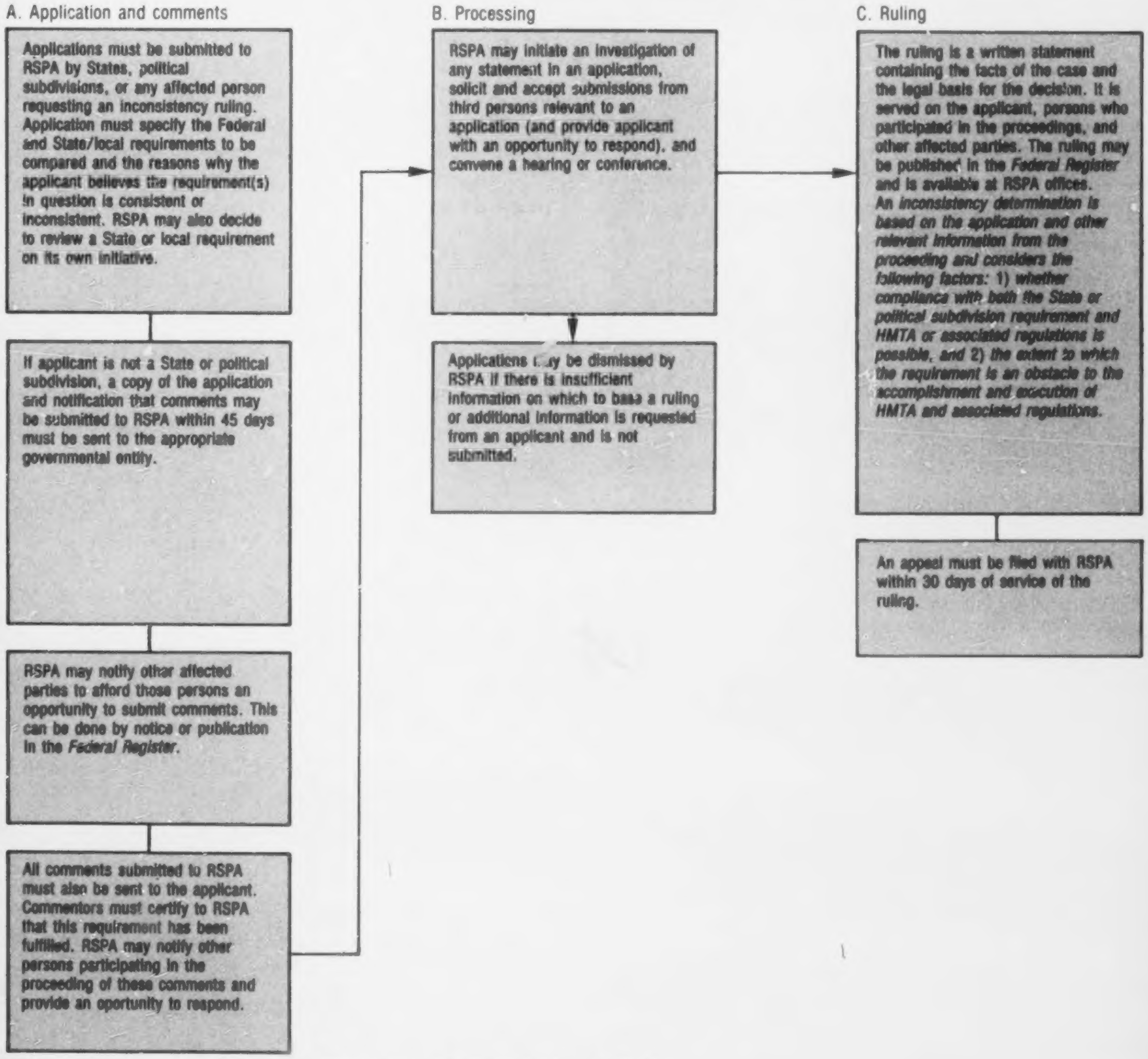
[138] 49 U.S.C. 1811.

[139] 49 CFR 107.203 to 107.211. The regulations were originally published on Sept. 9, 1976, 41 F.R. 38167. It should be noted that the U.S. Department of Transportation's administrative process does not address Commerce Clause considerations; these are reviewed by the courts.

[140] 49 CFR 107.209(c).

[141] U.S. Departments of Justice and of Transportation, Brief for the Department of Transportation as Amicus Curiae, *New Hampshire Motor Transport Association* v. *Flynn*, U.S. Court of Appeals for the First Circuit, No. 84-1226, November 1984, pp. 6-7.

Figure 4-8.—Procedures for Inconsistency Rulings



A. Application and comments

Applications must be submitted to RSPA by States, political subdivisions, or any affected person requesting an inconsistency ruling. Application must specify the Federal and State/local requirements to be compared and the reasons why the applicant believes the requirement(s) in question is consistent or inconsistent. RSPA may also decide to review a State or local requirement on its own initiative.

If applicant is not a State or political subdivision, a copy of the application and notification that comments may be submitted to RSPA within 45 days must be sent to the appropriate governmental entity.

RSPA may notify other affected parties to afford those persons an opportunity to submit comments. This can be done by notice or publication in the *Federal Register*.

All comments submitted to RSPA must also be sent to the applicant. Commentors must certify to RSPA that this requirement has been fulfilled. RSPA may notify other persons participating in the proceeding of these comments and provide an oportunity to respond.

B. Processing

RSPA may initiate an investigation of any statement in an application, solicit and accept submissions from third persons relevant to an application (and provide applicant with an opportunity to respond), and convene a hearing or conference.

Applications may be dismissed by RSPA if there is insufficient information on which to base a ruling or additional information is requested from an applicant and is not submitted.

C. Ruling

The ruling is a written statement containing the facts of the case and the legal basis for the decision. It is served on the applicant, persons who participated in the proceedings, and other affected parties. The ruling may be published in the *Federal Register* and is available at RSPA offices. *An inconsistency determination is based on the application and other relevant information from the proceeding and considers the following factors: 1) whether compliance with both the State or political subdivision requirement and HMTA or associated regulations is possible, and 2) the extent to which the requirement is an obstacle to the accomplishment and execution of HMTA and associated regulations.*

An appeal must be filed with RSPA within 30 days of service of the ruling.

NOTE: RSPA = Research and Special Programs Administration; HMTA = Hazardous Materials Transportation Act.

SOURCE: Office of Technology Assessment staff based on 49 *Code of Federal Regulations* 107.203 to 107.211.

eral requirements and does not unreasonably burden commerce. The factors considered by DOT in assessing whether interstate commerce is unduly burdened are:

- the extent to which increased costs and impairment of efficiency result from the State or local requirement;
- whether the State or local requirement has a rational basis;
- whether the State or local requirement achieves its stated goals; and
- whether there is a need for uniformity with regard to the subject concerned, and if so, whether the State or local requirement com-

petes or conflicts with those of other States or local entities.[142]

These criteria have been drawn from Supreme Court decisions regarding the validity of various State transportation safety requirements.[143] The procedures that have been developed for granting a waiver of preemption are presented in figure 4-9. Applications for waivers of preemption are considered by DOT only if the State or locality acknowledges that the requirement in question is inconsistent, DOT rules that it is inconsistent, or a court decides that the requirement is inconsistent with the HMTA.[144]

In lieu of requesting a waiver of preemption, State and local entities have the option of petitioning DOT to establish, amend, or repeal a Federal regulation. The steps involved in undertaking such an action are also set forth in 49 CFR.[145]

DOT Policy Guidance for State and Local Requirements

When DOT issued routing regulations for radioactive materials, Docket HM-164, an appendix was also published containing DOT policy and advice to State and local governments regarding their authority over motor carriers in relation to HM-164. State and local rules addressed by the appendix include those that effectively redirect or otherwise significantly restrict or delay highway movements of hazardous materials, and that apply because of the hazardous nature of the cargo. Permits, fees, and similar requirements are included if they have such effects. The definition excludes State or local emergency actions and traffic controls that are not based on the nature of the cargo, such as truck routes based on vehicles' weight or size.[146]

DOT explicitly notes that a State routing rule is inconsistent if it prohibits transportation by highway between two points without providing an alternate route or if it does not meet three criteria:

- it must be established by a State routing agency,
- it must be based on a comparative risk assessment at least as sensitive as the one outlined in DOT guidelines, and
- it must be based on solicitation and substantive consideration of views from affected States and local jurisdictions.

Local governments may regulate shipments of radioactive materials only if the routes they choose are consistent with those designated by Federal and State authorities. New York City, concerned about the safety of through shipments of spent nuclear fuel, has opposed the regulatory restrictions placed on municipalities by HM-164. This case is described in box 4B.

In addition, the appendix provides guidance on related State and local rules. It states that a requirement is inconsistent with HM-164 if it:

- conflicts with the physical security requirements of NRC or DOT requirements;
- requires additional or special personnel, equipment, or escorts;
- requires additional or different shipping papers, placards, or other warning devices;
- requires filing advance route plans containing information that is specific to individual shipments;
- requires prenotification;
- requires accident or incident reporting other than that needed for emergency assistance; or
- unnecessarily delays transport.

DOT Inconsistency Rulings

As of May 1986, 16 inconsistency rulings have been issued by DOT. The inconsistency rulings are lengthy legal analyses that address requirements established by States, local jurisdictions, and individual bridge and highway authorities. (Appendix B contains a description of each case and a summary of the inconsistency ruling decisions for the major types of requirements examined.) The scope of the requirements reviewed in these decisions ranges from regulations governing a particular aspect of hazardous materials transportation, such as shipping papers, to comprehensive regulatory programs. Most

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[142] 49 CFR 107.221(b).

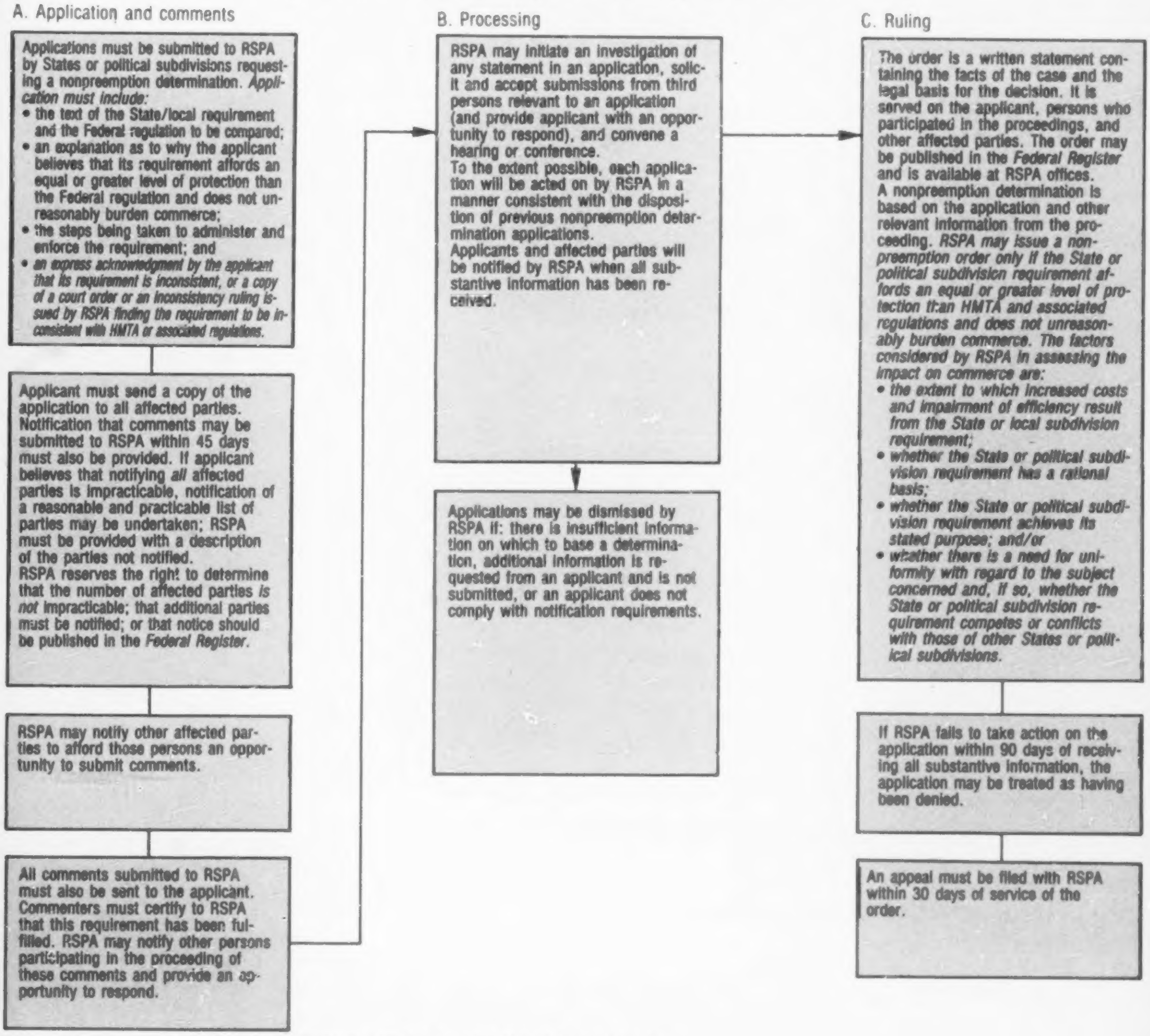
[143] 41 F.R. 38168, Sept. 9, 1976.

[144] 49 CFR 107.219(c).

[145] 49 CFR 106.31. Petitions to establish, amend, or repeal a regulation must: 1) set forth the text or substance of the regulation or amendment proposed, 2) explain the interest of the petitioner in the action requested, and 3) contain any information and arguments available to the petitioner to support the action sought.

[146] Note that the appendix to HM-164 is not a regulation and was intended to guide State and local governments contemplating rulemaking action as to the likelihood of such actions being deemed inconsistent. 49 F.R. 46634, Nov. 27, 1984.

Figure 4-9.—Procedures for Nonpreemption Determinations



A. Application and comments

Applications must be submitted to RSPA by States or political subdivisions requesting a nonpreemption determination. *Application must include:*
- the text of the State/local requirement and the Federal regulation to be compared;
- an explanation as to why the applicant believes that its requirement affords an equal or greater level of protection than the Federal regulation and does not unreasonably burden commerce;
- the steps being taken to administer and enforce the requirement; and
- *an express acknowledgment by the applicant that its requirement is inconsistent, or a copy of a court order or an inconsistency ruling issued by RSPA finding the requirement to be inconsistent with HMTA or associated regulations.*

Applicant must send a copy of the application to all affected parties. Notification that comments may be submitted to RSPA within 45 days must also be provided. If applicant believes that notifying *all* affected parties is impracticable, notification of a reasonable and practicable list of parties may be undertaken; RSPA must be provided with a description of the parties not notified.
RSPA reserves the right to determine that the number of affected parties *is not* impracticable; that additional parties must be notified; or that notice should be published in the *Federal Register*.

RSPA may notify other affected parties to afford those persons an opportunity to submit comments.

All comments submitted to RSPA must also be sent to the applicant. Commenters must certify to RSPA that this requirement has been fulfilled. RSPA may notify other persons participating in the proceeding of these comments and provide an opportunity to respond.

B. Processing

RSPA may initiate an investigation of any statement in an application, solicit and accept submissions from third persons relevant to an application (and provide applicant with an opportunity to respond), and convene a hearing or conference.
To the extent possible, each application will be acted on by RSPA in a manner consistent with the disposition of previous nonpreemption determination applications.
Applicants and affected parties will be notified by RSPA when all substantive information has been received.

Applications may be dismissed by RSPA if: there is insufficient information on which to base a determination, additional information is requested from an applicant and is not submitted, or an applicant does not comply with notification requirements.

C. Ruling

The order is a written statement containing the facts of the case and the legal basis for the decision. It is served on the applicant, persons who participated in the proceedings, and other affected parties. The order may be published in the *Federal Register* and is available at RSPA offices.
A nonpreemption determination is based on the application and other relevant information from the proceeding. *RSPA may issue a nonpreemption order only if the State or political subdivision requirement affords an equal or greater level of protection than HMTA and associated regulations and does not unreasonably burden commerce. The factors considered by RSPA in assessing the impact on commerce are:*
- *the extent to which increased costs and impairment of efficiency result from the State or local subdivision requirement;*
- *whether the State or political subdivision requirement has a rational basis;*
- *whether the State or political subdivision requirement achieves its stated purpose; and/or*
- *whether there is a need for uniformity with regard to the subject concerned and, if so, whether the State or political subdivision requirement competes or conflicts with those of other States or political subdivisions.*

If RSPA fails to take action on the application within 90 days of receiving all substantive information, the application may be treated as having been denied.

An appeal must be filed with RSPA within 30 days of service of the order.

NOTE: RSPA = Research and Special Programs Administration; HMTA = Hazardous Materials Transportation Act.

SOURCE: Office of Technology Assessment staff based on 49 *Code of Federal Regulations* 107.215 to 107.225.

of the requirements examined by DOT applied exclusively to highway transport; however, in three cases (Michigan; Vermont; and Covington, Kentucky) rail and water modes were also affected.

The decisions reached by DOT in each case were based on the application of the dual compliance and obstacle tests. The dual compliance test is a straightforward determination of whether compliance with both the State or local requirement and the applicable Federal requirement can be achieved. The obstacle test is somewhat more complex and involves an examination of the:

> . . . full purposes and objectives of Congress in enacting the HMTA and the manner and extent to which those purposes and objectives have been carried out through MTB's regulatory program.[147]

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[147] 44 F.R. 75568, Dec. 20, 1979.

The purposes and objectives that have been identified by DOT include protecting the Nation adequately against the risks to life and property inherent in the transportation of hazardous materials, and precluding a multiplicity of State and local regulations and the potential for varying and conflicting regulations.[148] Critics of DOT argue that safety and uniformity should not be given equal weight in the decision process. It is their belief that Congress was primarily concerned with safety; therefore, State and local requirements that vary from Federal ones but provide a greater degree of protection should be allowed.[149]

Generally, consistent non-Federal requirements are those DOT considers appropriate areas for State and local regulation and for which comparable Federal requirements have not been promulgated. Consistent requirements pertain to traffic control and safety hazards peculiar to a local area and include immediate notification of local officials when accidents occur, the use of headlights and vehicle separation distances, vehicle inspections, the imposition of penalties associated with valid local regulations, and certain types of communication equipment. When routing regulations increase safety and are enacted in consultation with affected neighboring jurisdictions, they are considered to be consistent requirements. In addition, DOT has indicated in these rulings that permit requirements as such are not inconsistent; it is the impact of such a requirement, such as causing shipment delays, that determines its validity. However, all of the permit requirements examined by DOT to date have been found to be inconsistent.[150]

Other inconsistent State and local requirements pertain to areas already subject to Federal regulation or result in traffic diversions and increased transit times. These requirements encompass packaging regulations; hazard communication systems, including hazard classification; shipping papers, marking, labeling, and placarding requirements; insurance requirements; prenotification; written accident reports; permits as a precondition to transport; and the use of additional escorts or equipment. In one case, a $1,000 fee, assessed per shipment of certain radioactive materials, was also determined to be inconsistent.[151] Furthermore, transportation bans or other routing restrictions enacted without evaluation of the safety impacts and consultation with affected communities were also found to be inconsistent.

The Role of the Courts

Aside from New York's legal challenge of HM-164, other Federal court decisions have been issued on the validity of specific State and local laws and regulations.[152] Most of the lawsuits have been filed by national or State trucking associations. In four cases, the lawsuits pertain to non-Federal requirements that are also the subjects of DOT inconsistency rulings.[153] While a DOT inconsistency ruling does not preclude judicial review, the courts have given weight to the rulings in their decisions.[154] Preemption provisions of other Federal laws are also considered by the courts as appropriate; for example, the Atomic Energy Act is relevant to cases involving shipments of radioactive materials. A brief

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[148] 47 F.R. 1231, Jan. 11, 1982.

[149] See "Defendants Memorandum of Law in Opposition to Plaintiff's Motion for Summary Judgment," *National Paint and Coatings Association Inc.* v. *City of New York*, Apr. 11, 1985, submitted to the U.S. District Court for the Eastern District of New York.

[150] These decisions, inconsistency rulings 2, 8, and 10 to 16, are described in app. B. In inconsistency ruling 3, while DOT found that a Boston regulation requiring transporters to carry permits in a vehicle cab was consistent, a ruling on the validity of the permitting system itself was not issued.

[151] The U.S. Department of Transportation (DOT) asserted that this requirement, established by Vermont, was inconsistent because it was discriminatory, diverted shipments, and replicated Federal emergency response efforts. Monies collected were to be used for a monitoring (response) team. See inconsistency ruling 15, 49 F.R. 46660, Nov. 27, 1984. As this report went to press, DOT issued inconsistency ruling 17 concerning an Illinois law that assesses a $1,000 fee for spent nuclear fuel shipments. DOT found the Illinois fee to be consistent with the HMTA. 51 F.R. 20926, June 9, 1986.

[152] *City of New York* v. *Ritter Transportation Inc.*, 515 F. Supp. 663 (1981); *National Tank Truck Carriers, Inc.* v. *City of New York*, 677 F. 2d 559 (1983); *New Hampshire Motor Transport Association* v. *Flynn*, 751 F. 2d 43 (1984); and *American Trucking Association, Inc.* v. *Larson*, 683 F. 2d 787 (1982). It should be noted that the *Larson* case upheld a Pennsylvania statute requiring periodic inspections of all motor carrier vehicles, whether or not they are used to transport hazardous materials and are registered in the State.

held a Pennsylvania statute requiring periodic inspections of all motor carrier vehicles, whether or not they are used to transport hazardous materials and are registered in the State.

[153] These cases include inconsistency rulings 1, 2, 3, and 5. App. B, which contains of a summary of inconsistency rulings, also describes related lawsuits.

[154] See for example, *New Hampshire Motor Transport Association* v. *Flynn*, 751 F. 2d 43 (1984) and *National Tank Truck Carriers, Inc.* v. *Burke*. 535 F. Supp. 509 (1982).

overview of relevant constitutional provisions is presented in box 4C.

Federal court decisions issued to date have generally been in agreement with DOT's inconsistency rulings. For example, the courts have struck down State and local requirements for written accident reports, vehicle equipment, vehicle markings and placards, container testing, and statewide curfews, while upholding requirements for local inspections, immediate accident reporting, operational requirements such as the use of headlights, and local curfews.

The courts have reviewed the validity of permit and license requirements established by New Hampshire, New York City, and Rhode Island. A 1983 New Hampshire law imposing license and fee requirements on vehicles transporting hazardous materials was upheld by the U.S. Court of Appeals for the First Circuit; these requirements provided transporters with the option of obtaining an annual or single-trip license.[155] A New York City regulation

Box 4C.—Constitutional Considerations

State and local entities traditionally exercise their police powers to protect public health, safety, and general welfare. On the other hand, the Federal Government is endowed with broad regulatory powers by the Supremacy and Commerce Clauses of the U.S. Constitution. The courts have established basic guidelines to be used in deciding whether State or local requirements are preempted by Federal law or are invalid because they unduly burden interstate commerce. These guidelines or tests are applicable to cases involving the transportation of hazardous materials.

The ability of the Federal Government to preempt State laws is derived from the Supremacy Clause, under which State laws that conflict with Federal statutes are nullified.[1] Existing case law on the subject of Federal preemption identifies four major factors considered by the courts in reviewing the validity of State or local regulatory actions: whether there is an explicit congressional statement in the applicable Federal statute; whether preemption can be implied (based on the legislative history, the extent to which there is Federal occupation of the subject area, and whether there is a need for national uniformity); whether compliance with both Federal and State law is possible; and whether the State law serves as an obstacle to accomplishing the purposes and objectives of Congress.[2]

In those instances where Congress has not preempted non-Federal action, State laws can still be invalidated if they are found to violate the Commerce Clause; this constitutional provision authorizes Congress to "regulate Commerce with foreign Nations, and among the several States, and with Indian Tribes."[3] While this statement does not explicitly limit State interference with interstate commerce, the "negative implication" of the Commerce Clause has been interpreted to mean that in the absence of congressional action, States may not erect barriers to the free flow of interstate commerce.[4]

There are two tests used by the courts in evaluating alleged violations of the Commerce Clause. First, a State or local requirement must be nondiscriminatory in order for it to be valid. An example of a discriminatory requirement is one that prohibits out-of-State shipments. Second, the courts must determine if interstate commerce is unduly burdened by balancing the impact of a non-Federal requirement on interstate commerce against the benefits it provides.[5]

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[1] The Supremacy Clause asserts that: "This Constitution and the Laws of the United States which shall be made in pursuance thereof, and all treaties made, or which shall be made under the authority of the United States, shall be the supreme law of the land; and the Judges in every State shall be bound thereby, anything in the Constitution of Laws of any State to the contrary not withstanding." U.S. Constitution, article VI, clause 2.

[2] For additional information on Federal preemption see, L.M. Trosten and M.R. Ancarrow, "Federal-State-Local Relationships in Transporting Radioactive Materials: Rules of the Nuclear Road," *Kentucky Law Journal*, vol. 68, No.2, 1979-80, p. 251; and Christopher Baum, "Banning the Transportation of Nuclear Waste: A Permissible Exercise of the States' Police Power?" *Fordham Law Review*, vol. 52, March 1984, p. 662.

[3] U.S. Constitution, article I, sec. 8, clause 3.

[4] Laurence Tribe, *American Constitutional Law* (Mineola, NY: The Foundation Press, Inc., 1978), p. 320.

[5] Trosten and Ancarrow, op. cit.; Baum, op. cit.

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[155] *New Hampshire Motor Transport Association* v. *Flynn*, 751 F. 2d 43 (1984). This opinion reversed the decision of the lower court.

requiring tank truck carriers of hazardous gases to obtain permits was also upheld.[156] The New York City permits were obtainable by telephone. On the other hand, Rhode Island permit regulations for transporters of liquefied natural gas or liquefied petroleum gas were found to be inconsistent by the U.S. District Court and the Court of Appeals.[157] In this case, the court found that the regulations, which required transporters to obtain a permit not less than 4 hours before or more than 2 weeks prior to each shipment, caused unnecessary delays and were inconsistent with the HMTA. DOT also concluded that the Rhode Island permit requirements were inconsistent.

Local routing restrictions have been addressed in two lawsuits. The New York City permit regulations for transporters of hazardous gases also required transporters who did not have pick-ups or deliveries in the city to use an established alternate route around it. Shipments into the city had to conform to specified routes and times established by the local authorities. The court found that the city regulations promoted safety and did not cause unnecessary delays, and that the route around the city was a "practicable alternative." In Boston, restrictions on the use of city streets were challenged both in Federal court and through DOT's inconsistency ruling process. After a lengthy review process, DOT decided that it could not reach a conclusion, because even though the routing restrictions appeared to enhance public safety, consultation with affected jurisdictions had been limited.[158] A final decision by the court has not yet been reached.

State restrictions imposed on the transportation of radioactive materials have also been the subjects of lawsuits. Laws prohibiting interstate shipments of radioactive wastes but allowing intrastate transportation were found to be unconstitutional. In one case, Illinois attempted to prevent shipments of spent nuclear fuel into the State for storage at a General Electric facility in Morris, Illinois. Another case involved a Washington State statute prohibiting shipments of low-level radioactive wastes destined for a disposal site in Richmond, Washington, from entering the State.[159]

CONCLUSIONS AND POLICY OPTIONS

A driving force behind enactment of the Hazardous Materials Act of 1975 was the improvement of regulatory and enforcement activities and the consolidation of authority within the Department of Transportation. During the past 10 years, responsibility for issuing most hazardous materials transportation regulations, except for bulk marine shipments, has been shifted to one entity, RSPA. However, the modal administrations continue to be responsible for safety regulations, including the development of some hazardous materials regulations applicable to each mode. Inspection and enforcement authority is shared by RSPA and the modal administrations. Other Federal agencies also have jurisdiction over certain types of hazardous materials and worker safety.

Moreover, the roles played by States and localities and by international organizations in the regulation of hazardous materials transportation have grown considerably since the HMTA was passed. The act provided the Secretary of Transportation with broad authority to promulgate a wide range of requirements. However, DOT has made several decisions about how to exercise its authority that have limited the application of its regulations, motivating State and local governments to act where they saw a need.

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[156] Both the District Court and the U.S. Court of Appeals for the Second Circuit upheld the New York City requirement. See *City of New York v. Ritter Transportation Inc.*, 515 F. Supp. 663 (1981); and *National Tank Truck Carriers, Inc.* v. *City of New York*, 677 F. 2d 270 (1982).

[157] *National Tank Truck Carriers, Inc.* v. *Burke*, 535 F. Supp. 509 (1982) and *National Tank Truck Carriers, Inc.* v. *Burke*, 698 F. 2d 559 (1983).

[158] 47 F.R. 18457, Apr. 29, 1982. It should be noted that the U.S. Department of Transportation also cited a concern about the validity of the data used for Boston's risk determination, but concluded that further refinement of the data would not have had a substantial effect on the outcome.

[159] *People of State of Illinois* v. *General Electric Co.*, 683 F. 2d 206 (1982); and *Washington State Building and Construction Trades, AFL-CIO* v. *Spellman*, 684 F. 2d 627 (1982).

First, DOT has chosen not to apply the hazardous materials regulations to most intrastate highway transport. Thus, for example, hazardous materials released from a truck owned by a company operating wholly intrastate, need not be reported to DOT (see chapter 2) and second- or third-hand cargo tankers that no longer meet Federal requirements may be used in some States (see chapter 3). On the other hand, some jurisdictions have established container regulations that are more stringent than Federal requirements. While States accepting Federal funds to support their enforcement programs are required to apply the hazardous materials regulations to both intrastate and interstate carriers, this does not ensure that the reporting requirements and container regulations will be applied.

Second, DOT has not exercised its authority to establish a registration program for shippers and carriers. This has meant that it does not have vital data about the extent of the group it regulates and that information useful to State and local officials is not available.

The legislative history of the HMTA indicates that Congress intended to preclude a multiplicity of State and local regulations and the potential for varying and conflicting regulations. Most State and local governments understand and agree with the need for uniform regulations, especially in areas related to containers and hazard communication. However, they believe that the steps they have taken are necessary to provide adequate safety in light of the risks posed by the transportation of hazardous materials. **State programs, like their Federal counterparts, are now characterized by a multiplicity and diversity of activities and areas of jurisdiction. While Federal grant programs have provided valuable assistance to States and have encouraged adoption and uniform enforcement of Federal regulations, great variation among State laws and regulations persists.**

Local governments usually do not directly benefit from Federal grant programs to the States. Consequently, they must rely on alternate sources of funding, such as licensing or permitting fees. Some jurisdictions have set fee levels to cover the administrative costs associated with registration, permit, or licensing programs, while others use fees to support inspection and enforcement or emergency response activities.

As most State and local requirements apply to highway shipments, the trucking industry has been affected most heavily. Interstate shippers and carriers argue that compliance with differing laws and regulations is confusing, time-consuming, and expensive. The costs include payment of registration, permit, and licensing fees which range from several dollars up to $1,000 per shipment, as well as operational expenses, such as driver costs, and expenses incurred by special staff to track changing requirements. Carriers have also found that certain types of requirements can cause delays in transit. Moreover, shipments may be diverted around jurisdictions that have imposed special requirements, shifting the risks to other States and communities.

There have been no comprehensive efforts to resolve existing interjurisdictional differences. Resolving questions of inconsistency between Federal, State, and local regulations, a task traditionally left to the courts, has been the focus of an advisory administrative review process established by DOT in 1976. In 16 inconsistency rulings, DOT has indicated that it believes State and local activity is limited to traffic control and narrow regulations that eliminate or reduce safety hazards peculiar to a local area. In addition, even when there is a unique local safety problem, consideration of the impacts of a requirement on other jurisdictions must be taken into account. DOT has also indicated that it is necessary to look at the impacts of State or local permit requirements, such as shipment delays, to determine their validity. Several cases reviewed by DOT have also been the subjects of lawsuits. **Although case-by-case reviews by DOT and the courts, a time-consuming and costly effort, provide criteria for assessing the validity of certain types of laws and regulations, OTA believes that they will not prevent continued adoption of differing State and local requirements.**

Registration, licensing, permitting, and notification requirements are important to States and localities because they provide valuable data and revenue. However, industry objects to both the fees that are assessed and the delays and diversions of shipments. Policy decisions must address both the financial and informational needs of State and local governments and ease the burden faced by interstate shippers and carriers. Thus, **Congress might require development of national guidelines for State**

and local information-collection programs in three areas: 1) to determine the number and location of hazardous materials shippers and carriers (registration or inventory), 2) to obtain assurances of fitness from shippers and carriers (licensing or permitting), and 3) to obtain information on the types of hazardous materials passing through or being produced in a community or region (notification). A consensus approach involving Federal, State, local, and industry representatives could be used to formulate the guidelines. **A standard form for requesting information could be created, similar to the uniform hazardous waste manifest developed jointly by DOT and EPA.** If detailed commodity flow data are needed, requirements that focus on information already available, such as Material Safety Data Sheets, should be emphasized. Special consideration should also be given to the information needs of bridge and tunnel authorities; this might include prenotification of certain high hazard shipments. In those States where the guidelines are adopted, localities may be required to obtain the information they need from their State agencies. In addition, reciprocity (including information sharing) between States in a given region could be encouraged. Assuming that alternative sources of financial support are provided for enforcement and emergency response (see discussion below), States and localities could be prohibited from assessing fees or required to limit fees to amounts sufficient to cover program administration costs. To assist interstate carriers and shippers, an annual compendium of State and local requirements and contacts, jointly developed by industry, DOT, and the States, could be published. Several public and private organizations have already compiled some of this information.

Carrier associations, insurance industry representatives, and State motor vehicle administrators and enforcement personnel have voiced strong support for a national truck driver's license requiring special training. Congress could authorize the development of such a license with special certification requirements for all hazardous materials, including gasoline. Driver certification could be linked to specific types of vehicles. Prerequisites for a license should include training and a clean record. Uniform license requirements and training standards could be developed by DOT, but States would be responsible for issuing licenses and administering the training program. State license fees could be set to cover program costs. California has already developed such a program. Another model is a program created by the European Common Market countries, which requires a hazardous materials driver's license but allows each country to pass its own implementing legislation.

In addition to the problem of differing licensing, registration, and permit requirements, the broader issue of varying State hazardous materials laws and regulations should also be addressed. Complete information about the scope of existing State laws and regulations pertaining to the transportation of hazardous materials is not presently available. While many States have adopted 49 CFR, some have excluded certain types or quantities of hazardous materials. Others have excluded private motor carriers and intrastate highway shipments are not regulated consistently. **An assessment of State hazardous materials laws and regulations to determine whether they are more or less stringent than Federal regulations could be required.** BMCS has already begun, at congressional request, a 5-year review of State motor carrier laws to determine those that are more or less stringent than Federal requirements in the areas of driver qualifications and training, hours of service, and equipment maintenance.[160] As part of the process, State laws will be reviewed by a panel convened by the Secretary of Transportation.[161] State laws that are less stringent than their Federal counterparts will be preempted; a law that is more stringent will not be preempted unless there is no safety benefit associated with it, the law is not compatible with Federal regulations, or enforcement of it causes an undue burden on interstate commerce. Another study of State motor carrier laws related to finances is being conducted by the National Governors' Association for the Federal Highway Administration. Congress could extend these ongoing efforts to encompass State hazardous materials regulations or initiate a separate review.

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[160] This review is authorized by the Motor Carrier Safety Act of 1984, Public Law 98-554, 98 Stat. 2829, 2835-2838. State guidelines for compiling, analyzing, and submitting their laws; regulations; and other information were published by the Bureau of Motor Carrier Safety on Jan. 10, 1985 (50 F.R. 1243).

[161] Section 209 of the Motor Carrier Safety Act of 1984, 98 Stat. 2838-2839.

In addition, Congress could consider requiring the expansion of those parts of 49 CFR administered solely by RSPA, such as the container regulations, to cover all intrastate highway transportation. Intrastate shippers and carriers of hazardous wastes and substances and flammable cryogenics are already subject to Federal regulation. Such a requirement would make RSPA regulations consistent with MCSAP requirements. If this approach is adopted, the preemption criteria noted above for existing laws and regulations should also apply to new requirements. Thus, intrastate regulations that increase safety and do not unduly burden interstate commerce would be allowed. **Congress might also wish to require DOT to reduce emphasis on detailed inconsistency rulings, which occur after a regulation is in place, and to provide technical and policy assistance to States or communities during the regulation-setting process.**

State and local hazardous materials enforcement activities, particularly for the highway mode, have become increasingly important during the past decade. While SHMED and MCSAP have provided States with grant monies to develop and implement enforcement programs, SHMED is ending this year and MCSAP funds must be used to support all motor carrier enforcement activities, not just hazardous materials. Moreover, financial support for emergency response training of local fire and police department personnel (described in chapter 5) is also a major concern of State and local governments. One funding mechanism that State and local governments have tapped is licensing, registration, and permit fees. States and municipalities are unlikely to discontinue such fees unless alternative funding sources are provided. Thus, **Congress could consider providing additional funds to States and localities for enforcement and emergency response programs**. Funding for the SHMED program could be extended and made available to all States with a requirement that State hazardous materials enforcement teams be developed. Special provisions could also be made to ensure that major metropolitan areas that undertake inspections be allocated a portion of the grant monies. A dedicated Federal fund to support emergency response activities could also be established.

Routing is an extremely important accident prevention tool available to State and local governments. Developing routing schemes that enhance overall regional safety is a difficult process, although the Portland, Oregon, experience demonstrates that it is possible. **The existing BMCS routing regulation for nonradioactive hazardous materials could be amended to provide more explicit guidance to communities. States designating alternate routes under HM-164 are already required to follow DOT guidelines for routing shipments of radioactive materials; this requirement, which includes a risk assessment and interjurisdictional consultation, could be extended to all hazardous materials. The development of criteria for routing shipments of radioactive and other hazardous materials by rail and water might also be considered. DOT technical assistance to States or communities for applying the risk assessment criteria and working through the route selection process could be extremely useful.** For example, the availability of computer software packages capable of comparing the risks associated with alternative routes, might be increased. One example is a computerized risk assessment model developed by Oak Ridge National Laboratory for DOD (see chapter 2). In addition, a compendium of routes designated by State and local governments might be published for motor carriers.

Finally, Congress could take steps to promote improved coordination within DOT, between Federal agencies, and between the Federal Government and State and local governments. **A standing coordinating committee could be established with representatives from each DOT modal administration; RSPA; other Federal agencies such as EPA, NRC, DOE, and FEMA; State and local governments; and industry**. This committee might be established within the framework of the National Response Team. It could be required to meet regularly with an agenda that includes:

- defining missions and roles of Federal agencies in the transportation of hazardous materials,
- coordinating Federal training programs,
- developing national guidelines as described above,
- setting a regulatory agenda for intra-agency and interagency issues, and
- coordinating common activities such as data collection and enforcement.

Subgroups could be formed to address areas of particular concern. More specifically, DOT and EPA could be directed to develop a joint program to educate small businesses that generate and transport hazardous wastes about DOT transportation requirements and the compatibility of wastes and containers. NRC, DOE, and DOT could be encouraged to develop a joint program to involve States, local governments, and Indian tribes in the decision-making process for Nuclear Waste Policy Act shipments and procedures.

Chapter 5

Training for Hazardous Materials Transportation Enforcement and Emergency Response

Photo credit: Rosalie Ott, NETC

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Chapter 5

Training for Hazardous Materials Transportation Enforcement and Emergency Response

INTRODUCTION

Hazardous materials are transported over the Nation's vast system of highways, rails, waterways, and airlanes, necessitating multimodal enforcement and emergency response capabilities at all levels of government. Enforcement of hazardous materials transportation and modal safety regulations is an effective accident prevention tool if it is carried out by a well-trained and experienced inspection force.[1] The training law enforcement officers receive—on applicable laws and regulations, vehicles and vessels used to transport hazardous materials, inspection techniques, and sometimes the chemical and physical properties of the hazardous materials themselves—directly influences the ability of those officers to conduct thorough inspections and audits.

When transportation accidents involving hazardous materials do occur, local police officers and firefighters are usually the first officials to appear at the site. How they respond to the conditions they find there depends in large part on whether they have received emergency response training for those types of accidents. Moreover, should any injuries result from exposure to toxic materials, medical personnel will be able to respond appropriately only if they have had training in the treatment of such injuries.

The population in need of enforcement and emergency response training is wide and varied. Regulations governing the transportation of hazardous materials are enforced by Federal inspectors, State department of transportation employees, State Police, State public works department personnel, and local fire and police officers. Moreover, according to the National Association of Chiefs of Police, there are between 450,000 and 500,000 local sheriffs and police personnel employed by State and local government alone.[2]

Emergency response activities are similarly divided among numerous entities. The National Fire Academy reports there are approximately 1.2 million firefighters nationwide, 85 percent of whom are volunteers, and the remaining 15 percent paid employees of municipal, county, or local governments.[3] Federal, State, and local government and law enforcement officials, civil defense volunteers, health professionals, and the approximately 400,000 basic emergency medical technicians[4] also need some training in assisting victims of hazardous materials accidents, depending on the scale and location of the accident and the materials involved.

For example, in December 1981, a tank truck carrying 40,000 pounds of toluene diisocyanate (TDI) skidded off the New York State Thruway and overturned, spilling some of its contents. TDI is transported in heated, insulated tank trucks to keep it in a liquid state. When the truck overturned, TDI spilled and congealed on exposure to the cold ground, contaminating the area around the tank truck as well as the clothing of two State troopers who had been called to the accident. Upon the officers' return to their warm car, some of the TDI that had adhered to their shoes and pants vaporized, and they inhaled the toxic fumes. TDI enters tissue cells and irritates eyes, nose, and throat, and when inhaled in large quantities, damages the lungs. As a result of their exposure, both of these officers suffered permanent respiratory damage and have been unable to return to police work.[5]

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[1] For example, under a U.S. Department of Transportation demonstration program, Utah increased the number of inspections it conducted by 330 percent; it also experienced a 43-percent reduction in accidents involving commercial vehicles during the same year. Similarly, Idaho experienced 37 percent fewer commercial accidents in the same year that it increased its inspections by 268 percent and its weighings by 218 percent. U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, "Interim Report, Commercial Motor Carrier Safety Inspection and Weighing Demonstration Program," unpublished typescript, August 1981.

[2] Gerald Arenberg, Executive Director, National Association of Chiefs of Police, personal communication, 1985.

[3] Joseph Donovan, then Director of the National Fire Academy, Federal Emergency Management Agency, Emmitsburg, MD, personal communication, 1985.

[4] Rocco V. Morando, Executive Director, National Registry of Emergency Medical Technicians, personal communication, June 1986.

Thus, State Police officers, who may enforce hazardous materials transportation regulations as part of their regular duties, also must be familiar with the dangers posed by the materials in case of an accident. The demands of their jobs illustrate some of the different levels of enforcement and emergency response training appropriate to meet the needs of some 2 million Federal, State, local, and private sector personnel.

What training is available to meet these diverse needs? In recent years, a number of studies and surveys have attempted to document the amount and type of training available.* The most recent is a congressionally mandated survey undertaken by the U.S. Department of Transportation (DOT) and the Federal Emergency Management Agency (FEMA). That survey identified 709 training organizations, public and private, that offer, or have recently offered, some form of hazardous materials training or planning,[6] although it did not determine how many will continue their courses. Responses to questionnaires provided by DOT and FEMA were received from 306 of these organizations, which together offer 468 training courses in some combination of enforcement, compliance, and emergency response.** The survey did not ask about the percentage of each course devoted to each type of training, limiting the analysis of the information collected. The courses offer a range of training activities, from home study training courses to more advanced programs involving lectures and field exercises.

Photo credit: National Fire Academy

Field exercises and simulations of transportation accidents involving hazardous materials are effective training methods for emergency personnel.

The survey, covering the years 1980 to 1984, found that the 306 organizations trained approximately 380,000 students at a total cost of $36.9 million. Funds expended on training increased each year during the 5-year survey period, with the total annual funds spent by survey respondents rising from under $5 million in 1980 to more than $10 million in 1984. Educational institutions, including State training institutes, fire academies, and community colleges, offered the largest number of courses (see table 5-1). The primary audience for courses offered

Table 5-1.—Summary of Training Courses, Hours, and Students by Organization Type, 1980-84

Organization type	Number of courses	Average hours per course[a]	Students completing per year
Private sector	45	7.5	23,187
Educational institution	164	26.7	12,995
Local government	79	19.2	9,098
State government	138	5.8	37,774
Federal Government	42	51.8	18,862

[a] Data are incomplete as some survey respondents did not provide information on the length of courses.

SOURCE: U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986.

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[5] Harvy Lipman, "Accidents Can, and Do, Happen," *Times Union*, Albany, NY, Apr. 7, 1985, p. 1.

*The reference section at the end of this report identifies the surveys, studies, and reports relevant to the transportation of hazardous materials.

[6] U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986.

**Enforcement and compliance training are similar in content but are taught from different perspectives. Enforcement training is designed for government inspectors whereas the target audience for compliance training is usually private sector employees.

Table 5-2.—Target Audiences for Compliance, Enforcement, and Response Training by Organization

	Number of courses				
Target audiences	Private sector	Educational institutions	Local government	State government	Federal Government
Shippers	20	47	2	39	6
Transportation companies	23	51	4	37	4
Private personnel	20	93	15	52	7
Elected officials	11	30	9	53	5
City/county administrators	10	39	20	61	4
Paid fire service	28	248	127	149	14
Volunteer fire service	30	246	55	150	18
Law enforcement	27	128	55	176	26
Emergency management	24	152	61	132	10
Public works	9	72	27	76	5

SOURCE: U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986.

by Federal and State governments is law enforcement officers, followed by volunteer and paid fire service and emergency management personnel. Local governments emphasize training for paid fire service employees (see table 5-2).

Although the survey identifies the bulk of Federal dollars spent and the number of students trained by federally sponsored programs, it does not provide comprehensive data on State and local training. However, data from the survey, which appear to show an abundance of training activities, have meaning only when they are compared to the number of people who need training. The Office of Technology Assessment's (OTA's) evaluation of that need, presented in this chapter, indicates that only 25 percent of the Nation's 2 million emergency response personnel have been adequately trained, and that enforcement training has reached only a portion of the State and local law enforcement officers.

The sections that follow identify the populations in need of training, analyze the availability and effectiveness of existing hazardous materials enforcement and emergency response training programs, describe industry's involvement in compliance and response training, and provide congressional policy options aimed at improving the delivery of hazardous materials training. Enforcement and emergency response activities are considered separately because they are administered and funded by different organizations, particularly at the Federal level. Additional information on industry compliance training is presented in chapter 3.

Sources of information for this chapter include an OTA workshop on State and local activities, the DOT/FEMA study, a recent survey of State hazardous materials enforcement activities, and extensive interviews with Federal, State, regional, local, and industry officials and training officers.

PART I: ENFORCEMENT ACTIVITIES AND TRAINING

Responsibility for enforcing hazardous materials transportation regulations is shared by Federal, State, and local agencies. In recent years, largely as a result of programs initiated by DOT, many States have established or improved programs to train highway enforcement officers and to educate shippers and carriers about compliance with hazardous materials regulations. Because Federal inspection capabilities have been decreasing, the importance of strong State and local efforts is underscored.

Federal Activities

Federal authority to enforce hazardous materials transportation regulations is distributed among numerous Federal agencies. Five of the agencies are within DOT: the Research and Special Programs Administration (RSPA) and four modal administrations—the U.S. Coast Guard, the Federal Aviation Administration (FAA), the Federal Railroad Administration (FRA), and the Federal Highway

Administration (FHWA). The other agencies are the U.S. Environmental Protection Agency (EPA), the Nuclear Regulatory Commission (NRC), and, peripherally, the Occupational Safety and Health Administration (OSHA). These Federal agencies train their own enforcement officers, to ensure that their training is both adequate and readily available. Additional enforcement and compliance training is sponsored by the U.S. Postal Service, and the U.S. Departments of Justice, Energy, and Defense. Some Federal training programs, primarily those for the highway mode, are directed at improving State and local enforcement capabilities.

Department of Transportation

The Hazardous Materials Transportation Act (HMTA) provides DOT with the authority to impose both civil and criminal penalties against persons who violate the act or associated regulations.[7] While RSPA is responsible for issuing the hazardous materials regulations under the act, it shares enforcement responsibilities with each of DOT's modal administrations. RSPA's inspection and enforcement efforts are focused primarily on container manufacturers, reconditioners and retesters, and packaging exemption holders. The Coast Guard, with assistance from the National Cargo Bureau and the American Bureau of Shipping, conducts waterfront facility and vessel inspections. FAA inspects freight at air carrier facilities, which serve as collection points for packages coming from freight forwarders and shippers. FRA has responsibility for rail shipper, carrier, and freight forwarder facilities. FRA also inspects railroad tank and freight cars as well as bulk container manufacturers. FHWA inspects motor carrier and shipper facilities in addition to roadside or terminal checks of motor vehicles. All five agencies conduct investigations of accidents and incidents involving hazardous materials. It is important to emphasize that the modal administrations are responsible for monitoring compliance with general safety regulations as well as with hazardous materials regulations.

The extent and effectiveness of DOT's enforcement activities were criticized by the U.S. General Accounting Office and the National Transportation Safety Board in several reports in the early 1980s.[8] These studies found that the number of inspections conducted by DOT agencies was low compared with the number of businesses engaged in the transportation of hazardous materials. OTA's examination of DOT's enforcement statistics from 1978 to 1984 indicates that the situation has not changed significantly in the years after those studies. (See tables 5-3 and 5-4.) For two transport modes—air and water—inspections have actually decreased. The Coast Guard figures are the most striking; waterfront inspections dropped from 16,865 in 1978 to 828 in 1984. While highway and rail inspections have increased, they are still extremely low relative to the total number of companies, vehicles, and vessels in operation. It is estimated that more than 30,000 shippers at 100,000 locations are subject to the HMTA, yet only 5,220 inspections were undertaken in 1984. Inspections of container manufacturers are also low; in 1984, only 144 out of more than 7,000 container manufacturers were inspected.

The principal reason for the low inspection rate is the shortage of DOT personnel, especially those with training in hazardous materials enforcement. Table 5-5 shows the number of full- and part-time inspectors by agency and the total work-years they represent over a 5-year period. With the exception of FRA, all of the agencies have experienced inspection staff reductions in recent years. The total number of work-years for all agencies decreased from 236.6 years in 1979 to 111 years in 1984. **As inspection forces have been decreasing, shipments of hazardous materials by truck alone have been increasing about 3 to 4 percent annually.**[9] **OTA**

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[7] Civil penalties, which may not exceed $10,000 per violation, are used when any person "knowingly commits an act which is in violation of" the law or regulations. Standards for determining the amount of a civil penalty require the U.S. Department of Transportation to "take into account the nature, circumstances, extent, and gravity of the violation committed and, with respect to the person found to have committed such violation, the degree of culpability, any history of prior offenses, ability to pay, effect on ability to continue to do business, and such other matters as justice may require." Criminal sanctions apply when persons are found guilty of willful violations of the Hazardous Materials Transportation Act or a regulation; penalties under these circumstances may not exceed $25,000 and/or 5 years in prison for each offense (49 U.S.C. 1809(a)).

[8] For example, see U.S. General Accounting Office, *Programs for Ensuring the Safe Transportation of Hazardous Materials Need Improvement*, CED-81-5 (Washington, DC: Nov. 4, 1980); and National Transportation Safety Board, *Status of Department of Transportation's Hazardous Materials Regulatory Program*, NTSB-SR-81-2 (Washington, DC: Sept. 29, 1981).

[9] Mark Abkowitz and George List, "Hazardous Materials Transportation: Commodity Flow and Information Systems," OTA contractor report, unpublished typescript, January 1986.

Table 5-3.—Number of Hazardous Materials Inspections and Investigations of Vehicles and Vessels

Agency/enforcement activity	1978	1979	1980	1981	1982	1983	1984
United States Coast Guard:							
• Vessels inspected[a]	40,886	39,643	39,138	35,450	28,641	23,711	20,297
• Accidents/incidents investigated	4,135	9,148	4,130	4,060	9[b]	16	4
Federal Railroad Administration:							
• Railroad tank cars inspected	16,208	15,926	19,010	26,580	39,171	31,641	40,820
• Railroad freight cars inspected	7,783	7,620	7,914	7,100	13,024	10,547	13,001
• Accidents/incidents investigated	405	398	523	629	538	426	553
Federal Highway Administration:							
• Motor vehicles inspected	3,790	3,470	3,362	6,061	5,980	7,536	6,325
• Accidents/incidents investigated	398	121	121	201	135	153	147
Federal Aviation Administration:							
• Accidents/incidents investigated	150	142	21	69	94	54	51
Research and Special Programs Administration:							
• Accidents/incidents investigated	2	2	1				

[a] 1982-84 data include bulk and break bulk vessels. 1978-81 data include only break bulk vessels. Break bulk refers to intermodal tanks and packaged goods.

[b] Prior to 1982, data on all commercial vessel accidents and incidents, involving hazardous and nonhazardous materials, were included in DOT's annual reports. Beginning in 1982, data included in the annual reports were limited to hazardous materials accidents and incidents resulting in damages exceeding $50,000, a death, or serious injury.

SOURCE: Office of Technology Assessment based on U.S. Department of Transportation Annual Reports.

Table 5-4.—Number of Hazardous Materials Inspections of Operations and Facilities

Agency/type of inspection	1978	1979	1980	1981	1982	1983	1984
United States Coast Guard:							
• Waterfront	16,865	14,784	19,546	5,661[a]	3,603	662	828
Federal Aviation Administration:							
• Packages/shipping documents					18,758	10,286	9,660
• Carriers	6,506	6,334	1,698	6,064	6,418	4,055	3,818
• Shippers				463	587	181	
• Freight forwarders							312
Federal Highway Administration:							
• Carriers	1,521	1,556	1,470	2,406	3,419	3,369	2,957
• Shippers	1,203	1,343	1,673	2,109	2,849	2,758	2,808
• Container manufacturers	95						
Federal Railroad Administration:							
• Carriers	2,014	1,583	1,892	3,183	3,969	3,976	4,382
• Shippers	672	640	983	1,805	890	2,064	2,300
• Freight forwarders	114	89	76	91	72	108	135
• Container manufacturers	109	128	149	197	30	45	102
Research and Special Programs Administration:							
• Carriers	15		1				
• Shippers	72	62	119		70	89	112
• Freight forwarders	6	33					
• Shipment observations			90	136	20	40	559
• Drum reconditioners		90	117	35	17	13	15
• Cylinder retesters			32	4	15	11	20

[a] Prior to 1981, data on waterfront facility inspections and spot checks for break bulk cargo were included in DOT's annual report. In 1981 and 1982, data on bulk liquid facility inspections were also included. Beginning in 1981, facility spot checks were discontinued due to budget reductions; the number of facility spot checks conducted in 1978, 1979, and 1980 were 14,986; 13,007; and 17,954, respectively. Break bulk refers to intermodal tanks and packaged goods.

SOURCE: Office of Technology Assessment based on U.S. Department of Transportation Annual Reports.

Photo credit: U.S. Coast Guard

Coast Guard inspection requirements include an examination of the vessel and its loading apparatus.

concludes that the number of inspectors is insufficient to ensure adequate inspection levels.

Enforcement programs are further hampered by the absence of complete data on shippers and carriers subject to the HMTA; one benefit of a registration program, described in chapter 2, would be the identification of the regulated community. Moreover, procedures followed by RSPA and the modal administrations for tracking violation histories, targeting inspections, and assessing penalties vary considerably.[10] An intermodal working group has recently been established within DOT to improve coordination of enforcement activities.[11]

DOT Enforcement Training.—The Transportation Safety Institute (TSI), a multimodal training establishment supported by the Department of Transportation, provides most of the hazardous materials transportation training for Federal employees. TSI courses are also open to State and local government employees and to private industry. General hazardous materials enforcement and compliance training and specialized training for each mode are available through TSI, both at TSI's facility in Oklahoma City and at State-operated sites on request.

Many States without sufficient resources to develop independent training programs send their inspectors to TSI courses. Priority for enforcement courses has been given to trainees from States participating in Federal grant programs. Between 1980 and 1985, 7,895 students were trained at TSI's Oklahoma City facility at a total cost of $1,077,600. State and local government employees made up more than half of the total student body for that period.[12] A summary of the courses offered by each DOT agency at TSI and other locations is presented in table 5-6.

Courses for both enforcement and inspection personnel and for shippers and carriers of hazardous materials are offered by RSPA. RSPA's general hazardous materials enforcement and inspection course has three phases: a self-study introduction that the student completes before attending class; a week of classroom instruction based on case studies; and a field exercise to be completed independently by the student once back on the job. Specific courses on cargo tanks and radioactive materials are also offered by RSPA. The intensive radioactive materials course, cosponsored with the Bureau of Motor Car-

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[10] See U.S. General Accounting Office, op. cit.; National Transportation Safety Board, *Federal and State Enforcement Efforts in Hazardous Materials Transportation By Truck*, NTSB-SEE-81-2 (Washington, DC: Feb. 19, 1981); Colin S. Diver, "A Study of the Effectiveness and Fairness of DOT Hazardous Materials Enforcement Penalties," Report to the General Counsel, U.S. Department of Transportation, June 1980; U.S. General Accounting Office, *Stronger Enforcement Would Help Improve Motor Carrier Safety*, GAO/RCED-85-64 (Washington, DC: Sept. 5, 1985); and U.S. General Accounting Office, *Management Improvement Could Enhance Enforcement of Coast Guard Marine Safety Programs*, GAO/RCED-85-59 (Washington, DC: Aug. 15, 1985).

[11] U.S. Department of Transportation, Research and Special Programs Administration, *Annual Report on Hazardous Materials Transportation—Calendar Year 1984* (Washington, DC: 1984), p. 29.

[12] Of the 7,895 students, 4,619 were State and local employees, while 1,784 were employed by the government. Other attendees were industry personnel and foreign students. David Goodman, Hazardous Materials Training Instructor, Transportation Safety Institute, Oklahoma City, OK, personal communication, Mar. 30, 1986.

Table 5-5.—Number of Hazardous Materials Transportation Inspectors and Work-Years[a]

	1979	1980	1981	1982	1983	1984
Inspectors—full-time:						
United States Coast Guard	0	0	0	0	0	0
Federal Aviation Administration	12	12	10	0	10	11
Federal Highway Administration	9	9	9	0	8	7
Federal Railroad Administration	19	24	25	23	33	34
Research and Special Programs Administration	9	10	7	6	6	7
Total	49	55	51	29	57	59
Inspectors—part-time:						
United States Coast Guard	770	770	1,298	403	570	570
Federal Aviation Administration	623	176	155	138	102	102
Federal Highway Administration	152	161	153	149	144	142
Federal Railroad Administration	61	64	129	129	158	166
Research and Special Programs Administration	0	0	1	1	1	1
Total	1,606	1,171	1,736	820	975	981
Total work-years:						
United States Coast Guard	115.50	115.50	155.76	50.00	40.00	12.00
Federal Aviation Administration	36.90	19.04	17.75	8.20	14.08	15.00
Federal Highway Administration	47.00	49.25	47.25	40.20	25.28	28.00
Federal Railroad Administration	28.20	33.60	34.65	33.00	46.40	48.00
Research and Special Programs Administration	9.00	10.00	7.50	6.75	6.75	7.50
Total	236.60	227.39	262.91	138.15	132.51	110.50

[a] The term work-years refers to the aggregate annual time spent by all inspectors in a mode.

SOURCE: Office of Technology based on U.S. Department of Transportation Annual Reports.

rier Safety, trained 120 students between 1980 and 1984.[13] Another course, designed to provide management-level employees of companies involved in the transportation of hazardous materials with basic working knowledge of the regulations, is taught at TSI.

In addition, a hazardous materials "train-the-trainer" course is offered by RSPA; train-the-trainer courses instruct individuals at a central location and then provide trained students with additional materials so that they can return to their jurisdictions and train others. This approach is a cost-effective way to augment training at the State and local levels. A network of such trained trainers, affiliated with the Commercial Vehicle Safety Alliance, is described later in this chapter.

The Federal Highway Administration's Bureau of Motor Carrier Safety (BCMS) currently offers a basic 8-hour training course in hazardous materials for State agencies. This course is given primarily to State law enforcement personnel by BMCS field staff; approximately 145 of these classes are offered each year. BMCS estimates that 14,460 students attended the basic 8-hour class during the period 1980-84.[14] In addition, courses on general motor carrier safety regulations are offered at TSI.[15]

Hazardous materials training for FRA inspectors is also available from TSI. Two courses—basic and advanced—provide instruction on the hazardous materials regulations applicable to the rail mode, with an emphasis on packaging and labeling of hazardous commodities. FRA inspectors who have attended a TSI training course may attend training programs at the Association of American Railroad's Transportation Test Center in Pueblo, Colorado.[16] Extensive training in general rail safety is also available at TSI.

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[13] Data on numbers of courses and students were obtained from the Bureau of Motor Carrier Safety survey form completed for the U.S. Department of Transportation/Federal Emergency Management Agency study.

[14] Ibid.

[15] More extensive hazardous materials courses and a course on hazardous wastes transport were taught for a limited period of time, but they have been discontinued. Two new training programs will be introduced in 1986 and 1987. The first, which will be given at U.S. Department of Transportation regional offices, is on motor carrier safety organization and management objectives; the other is a 40-hour course at the Transportation Safety Institute covering hazardous materials and wastes enforcement. Bill Herster, Bureau of Motor Carrier Safety, Federal Highway Administration, personal communication, Apr. 3, 1986.

[16] Federal Railroad Administration inspectors may also participate in training programs offered by a chemical company in Milford, PA. Frank Fanelli, Federal Railroad Administration, U.S. Department of Transportation, personal communication, Apr. 2, 1986.

Table 5-6.—Department of Transportation Hazardous Materials Compliance and Enforcement Training Courses

Agency and course	Course type[a]	Hours per course	Students completing per year
Research and Special Programs Administration:			
Hazardous Materials Compliance and Enforcement[b]	CE	40	1,000
Intermodal Transportation of Hazardous Materials[b]	C	40	80
Hazardous Materials Train-the-Trainer[b]	CE	80	45
Cargo Tank Compliance and Enforcement[b]	CE	24	300
Cargo Tank Roadside Inspection[b]	CE	32	250
In-Depth Radioactive Materials[b c]	CE	32	40
Federal Highway Administration—Bureau of Motor Carrier Safety:			
Hazardous Materials for State Agencies[b]	CE	8	2,892
U.S. Coast Guard:[d]			
Port Operations Department	CER	320	70
Marine Safety Petty Officer	CER	240	210
Marine Safety Inspection Department Course	CE	280	70
Marine Safety Explosive Handling Supervisors Course	CE	80	240
Federal Railroad Administration:			
Hazardous Materials:			
Advanced[e]	CE	40	50
Basic[e]	CE	40	25
Railroad Operating Course[b]	CE	8	6,107
Federal Aviation Administration:			
Air Transportation of Hazardous Materials:			
Advanced[e]	CE	40	40
Basic[e]	CE	72	40
Multimodal Shippers Course[e]	C	32	40

[a] C = Compliance, E = Enforcement, R = Response.
[b] Courses offered at Transportation Safety Institute and State locations.
[c] This course is offered by Research and Special Programs Administration and cosponsored by the Federal Highway Administration.
[d] All courses offered at Yorktown, Virginia Training Center.
[e] Courses offered at Transportation Safety Institute.

SOURCE: Office of Technology Assessment based on U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986.

FRA has also sponsored the development of a video program for railroad and hazardous materials training. The Port Terminal Rail Authority (PTRA) in Houston received a grant from FRA to produce a demonstration program in conjunction with the Southern Pacific Railroad. One condition of the grant was that the training be made available to other railroads. The new system has been used to train an estimated 500 PTRA and Southern Pacific employees, and it has been demonstrated in several other locations. Other railroads have expressed interest in the program and are purchasing the necessary computer equipment.[17]

The Coast Guard offers hazardous materials enforcement training at its Marine Safety School in Yorktown, Virginia. Although Yorktown courses are open to civilians and industry as space is available, most students are Coast Guard personnel. A 7-week course, offered by the Marine Safety Inspection Department, provides training on domestic and international hazardous materials regulations. A shorter class on explosives is also taught at Yorktown. Two additional courses, one for petty officers and another for officers, address basic marine safety; these courses cover both emergency response and enforcement. In addition to the Yorktown courses, occasional seminars are conducted in major port and harbor areas for shippers and carriers.*

FAA requires all new inspection and enforcement staff to attend a basic 2-week training course at TSI concerning the air transportation of hazardous materials. Subsequently, inspectors attend a 1-week advanced refresher course every 2 years; this course was attended by 190 inspectors from 1980 to 1984.[18] In addition, a multimodal course, emphasizing the highway and air modes, is given at TSI for FAA depot and other staff responsible for handling, storing, and shipping hazardous materials.

Other Federal Agencies

Two other Federal agencies—EPA and NRC—have enforcement responsibilities relevant to the transportation of hazardous materials. EPA and NRC have delegated substantial regulatory and enforcement authority to the States. However, while NRC provides training for State personnel, most courses emphasize facility regulations. EPA enforcement efforts are focused on land disposal facility activities, and no formal enforcement training is offered to the States. EPA and NRC activities are described in box 5A. In addition, OSHA, responsible for the safety of workers employed by shippers and carriers of hazardous materials, offers courses

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[17] Larry Helms, Port Terminal Rail Authority, personal communication, Apr. 1, 1986.

*A U.S. Coast Guard seminar on hazardous materials for shippers and carriers held at the Port of New York and New Jersey in April 1986 was attended by approximately 100 persons.

[18] John Garrett, Federal Aviation Administration, personal communication, Apr. 2, 1986.

Box 5A.—The Environmental Protection Agency and the Nuclear Regulatory Commission Enforcement Training Activities

U.S. Environmental Protection Agency

The inspection and enforcement activities of the U.S. Environmental Protection Agency (EPA) relevant to transportation concern generators and transporters of hazardous wastes. EPA requirements for transporters of hazardous wastes consist of the U.S. Department of Transportation's (DOT) regulations for hazard communication, packaging, and reporting discharges, as well additional notification, marking, manifest, and cleanup requirements. Federal legislation allows States to administer and enforce hazardous waste programs in lieu of EPA if they meet certain requirements; programs in all but 7 States have been approved by EPA, and thus, 43 States are responsible for conducting inspections.

Under a 1980 Memorandum of Understanding between EPA and DOT, EPA may bring an enforcement action involving a waste transporter if the transportation is ancillary to other activities normally under EPA's jurisdiction, such as the storage or disposal of hazardous wastes. Additionally, EPA has agreed to make available to DOT any information regarding possible Hazardous Materials Transportation Act violations.

However, only a small percentage of EPA and State inspections target generators or transporters of hazardous wastes. Guidance for EPA regional and State hazardous waste regulatory programs requires only that sufficient resources be reserved to inspect 4 percent of the generators and transporters in their jurisdictions.[1] Moreover, few EPA inspectors receive formal training in the DOT hazardous wastes regulations. Three EPA regional offices have sent employees to Transportation Safety Institute training courses in the past, and only one region meets annually with DOT regional staff to coordinate inspection and enforcement activities and discuss any relevant regulatory changes.[2] At the State level, Federal funding under the Resource Conservation and Recovery Act may be used for staff training; EPA recommends that up to 5 percent of State grants be earmarked for training activities.[3] (See appendix A for additional information on EPA's hazardous wastes program.)

Nuclear Regulatory Commission

Responsibility for regulating the transportation of radioactive materials is divided between the Nuclear Regulatory Commission (NRC) and DOT. Under a Memorandum of Understanding, NRC is responsible for the design and performance of packages used to transport high-level radioactive materials; DOT has regulatory authority over packages used to ship low-level radioactive materials. Inspection and enforcement authority is similarly divided, although the agencies have agreed to consult each other on the results of inspections when they are related to each other's requirements. States participating in the NRC's Agreement State program have been granted regulatory and enforcement authority for certain types of radioactive materials.* NRC inspectors from three program areas—reactors, fuel facilities, and materials licensees—conduct both facility and transportation-related inspections.** Nationwide there are 30 to 40 reactor inspectors, 10 to 12 fuel facility inspectors, and 30 to 40 materials inspectors.[4]

Numerous training courses have been developed for NRC staff, some pertaining to specific subjects such as the transportation and packaging of radioactive materials. In addition, inspection and enforcement training for Federal and State employees is offered by NRC's Technical Training Center in Chattanooga,

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[1] U.S. Environmental Protection Agency, 1987 Resource Conservation and Recovery Act Implementation Plan, unpublished typescript, 1986, p. 14.

[2] Information on regional activities was provided by the following Environmental Protection Agency staff members: Jerry Levi and Dennis Huebner, Region I; Drew Lessmar, Region II; Jim Webb and Bruce Smith, Region III; Alan Antley, Region IV; William Miner, Region V; Jim Stiebing and Dave Peters, Region VI; Bob Dona, Region VII; Diana Shannon, Region VIII; Philip Bobel, Region IX; and Dick Bauer and Betty Wiese, Region X, March 1986. The lack of coordination between EPA and DOT inspectors was also described in a 1983 congressional report. U.S. Congress, House Committee on Government Operations, *Improving the Effectiveness of the Bureau of Motor Carrier Safety and Its Enforcement of Hazardous Materials Regulations*, Report No. 98-562 (Washington, DC: U.S. Government Printing Office, Nov. 17, 1983), pp. 52-55.

[3] U.S. Environmental Protection Agency, op. cit., p. 25.

*Twenty-eight agreement States are responsible for byproduct material (radioisotopes), source materials (raw materials for atomic energy), small quantities of special nuclear materials, uranium and thorium tailings, and the permanent disposal of low-level radioactive wastes. In addition, States have always had primary responsibility for the regulation of X-ray machines and other radiation producing equipment, accelerator-produced radioactive materials, and radium.

**The Nuclear Regulatory Commission is responsible for inspecting its licensees, which include public utilities, universities with accelerators and nuclear laboratories, hospitals, and industries that handle radioactive materials. Materials inspectors cover 5,000 to 6,000 small licensees, hospitals, laboratories, accelerators, etc.

[4] Alfred Grella, U.S. Nuclear Regulatory Commission, personal communication, May 1986.

Tennessee; the center also offers training at other locations. One NRC course is devoted entirely to the inspection and enforcement of regulations for the transportation of radioactive materials. Although the course was not offered by the Training Center in 1985, it was offered in each of the five NRC regional offices in 1985 and at the Center in 1986. NRC's office of State programs also sponsors a 5-day course on the transportation of radioactive wastes for State regulatory personnel; this program is held once a year in Columbia, South Carolina or Richland, Washington.[5]

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[5] Ibid.

on hazardous materials and fire safety principles. The National Mine Health and Safety Academy, also affiliated with the Department of Labor, provides compliance, enforcement, and response training on hazardous materials.

Limited hazardous materials training is also offered to employees of the U.S. Postal Service. The Postal Service generally permits the mailing of hazardous materials classified by DOT as Other Regulated Material, as well as other hazardous materials such as etiologic agents and radioactive substances.[19] Packages containing hazardous materials sent by mail must comply with DOT regulations. Because Postal Service personnel generally may not open sealed mail, information on the contents of a package are obtained only from the mailer or if a package releases its contents. Thus, virtually all Postal Service employees need training in several areas: determining whether packages containing hazardous materials can be mailed, ensuring that DOT packaging and marking requirements are met, handling packages containing hazardous matter, and responding appropriately in the event of a hazardous materials release. A special hazardous materials training program was initiated by the Postal Service in 1982. As part of standard employee training, six training modules on hazardous materials are now offered at some 100 Postal Employee Development Centers. One module is a general awareness presentation, and the others are directed at specific employee groups—supervisors, acceptance clerks, transfer clerks, carriers, and mail handlers. Since the hazardous materials training program began, more than 37,000 employees have been trained;[20] however, this number is only a small percentage of the total Postal Service force.*

More generalized inspection and enforcement training for Federal inspectors is available through the Department of Justice's Federal Law Enforcement Training Center (FLETC). FLETC, located in Glynco, Georgia, provides 12 basic law enforcement training programs to 56 participating organizations, including Federal employees and some State and local enforcement personnel.[21]

The Department of Defense (DOD) and the Department of Energy (DOE), as shippers and carriers of hazardous and radioactive materials, also provide compliance training for their employees. A recent addition to hazardous materials enforcement training at TSI is a course for DOD personnel. The course, patterned after other TSI enforcement courses, is expected to begin in 1986 and will accommodate 50 students per class. The Air Force has developed courses on air and surface transportation of hazardous materials, and the Army Logistics Management Center provides training on handling hazardous materials.

The Transportation Management Program of the Department of Energy offers basic and advanced workshops on the transportation of radioactive materials, at which DOT and NRC regulations are covered. DOE courses are primarily for DOE employees and contractors, although commercial carriers and other government personnel may attend some courses as space permits. DOE also offers short orientation seminars on the transportation of hazardous materials for State and local police and fire officials.[22]

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[19] One example of an Other Regulated Material is a consumer commodity; the U.S. Department of Transportation hazard classes are defined in table 4-4, ch. 4. The U.S. Postal Service mailability requirements for hazardous materials are specified in U.S. Postal Service, *Acceptance of Hazardous, Restricted, or Perishable Matter*, publication 52 (Washington, DC: May 15, 1981 (periodically updated by transmittal letters)).

[20] The U.S. Postal Service trained 7,139 employees in 1982, 9,556 in 1983, 9,734 in 1984, and 10,730 in 1985. Steve Gordon, U.S. Postal Service, personal communication, Apr. 3, 1986.

*The employee figure is for fiscal year 1985. Of the 744,490 employees, 585,943 are full-time staff.

[21] Peggy Haywood, Public Affairs Officer, Federal Law Enforcement Training Center, Glynco, GA, personal communication, Apr. 2, 1986.

State and Local Activities

The contribution made by State and local inspection and enforcement forces to accident prevention has become increasingly important in light of a declining Federal enforcement presence and rising numbers of hazardous materials shipments. The number of State and local law enforcement officers is estimated to be 450,000 to 500,000.[23] Two Federal programs, directed at increasing State capabilities in managing the transportation of hazardous materials, grew out of studies conducted in the 1970s that identified needed improvements in State enforcement, data collection, and recordkeeping activities.

The first program, the State Hazardous Materials Enforcement Development (SHMED) program, was begun in 1981 by RSPA and is scheduled to end this year. Under SHMED, 25 States conducted programs funded by Federal contracts to strengthen State enforcement capabilities and promote uniformity in State hazardous materials safety regulations and enforcement procedures. Although all modes are covered by the program, highway transportation programs have been emphasized by many States. Training of enforcement personnel, especially for highway inspections, has been a major activity.

Initially, SHMED training involved a 2-week residential course at DOT's Transportation Safety Institute. However, this arrangement proved to be too expensive for the States; thus, RSPA's three-phase inspection and enforcement course was developed, and hazardous materials training within the States was offered. The train-the-trainer program at TSI was also initiated. By government standards, the SHMED program is small; by the time it expires, it will have expended only about $3 million. Nevertheless, it has been extraordinarily influential in shaping State enforcement activities and in determining the components of an effective program.

The second Federal grant program is the Motor Carrier Safety Assistance Program (MCSAP), which funds State enforcement and regulatory enforcement activities for highways. MCSAP is administered by the Bureau of Motor Carrier Safety. The thrust of the 5-year program is to help States enforce motor carrier safety regulations and increase safety inspections of intrastate and interstate commercial vehicles. General safety and hazardous materials activities are eligible for funding. Both development and implementation grants are available under MCSAP. To receive implementing funds, a State must develop an enforcement and safety program plan and designate a lead agency; set aside adequate resources to administer the program and enforce the regulations; and have statutory authority to enter vehicles and facilities. In addition to financial and regulatory development support, a basic 8-hour hazardous materials training course for State law enforcement personnel is offered by BMCS field staff. Actual appropriations for MCSAP have been lower than the amounts authorized; however, the maximum funding level of $50 million has been requested for fiscal year 1987.

The end of the SHMED program in 1986 means that Federal support of State multimodal hazardous materials enforcement capabilities will decrease. MCSAP will continue to provide States with funds for the highway mode, but monies are not targeted exclusively for hazardous materials inspection and enforcement activities. Without sustained Federal support, many States will be stymied in their efforts to develop or improve inspection, regulation, and enforcement for air, water, and rail modes of transportation. This prospect especially concerns States with high concentrations of nonhighway hazardous materials shipments. Even where State inspectors have been trained in rail safety procedures, they cannot conduct hazardous materials inspections, because authority to do so has not been granted to States.

Moreover, Federal grant programs have not provided any direct support for local inspection and enforcement activities. Major metropolitan areas, responsible for enforcing Federal, State, and local regulations, often turn to general revenues or permit, registration, or licensing fees to support their inspection and enforcement programs. (For more information on SHMED, MCSAP, and local requirements, see chapter 4.)

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[22] Five seminars have been held since the program began in 1985 and were attended by 223 people. Theresa Yearwood, Science Applications International Corp., Oak Ridge, TN, personal communication, Apr. 11, 1986.

[23] Gerald Arenburg, Executive Director, National Association of Chiefs of Police, personal communication, July 1985.

State Inspections and Enforcement

Although some States, such as Maryland, Michigan, and Massachusetts, have taken steps to centralize hazardous materials inspection activities,[24] hazardous materials inspection authority in many States is divided among several agencies. Usually, the State Police or highway patrol is charged with roadside inspections, and another agency, such as the department of transportation, has authority to conduct inspections of terminals. In addition, a special agency may be empowered to inspect carriers of radioactive materials.

Systematic and consistent inspection procedures are important if widespread compliance with hazardous materials transportation regulations is to be achieved. A recent survey of 47 States, conducted by SHMED States, found that 42 States have established inspection procedures based on manuals or guidance provided by DOT, the Commercial Vehicle Safety Alliance (CVSA), or their own agencies.[25] Created in 1980, CVSA now includes 26 States and the Canadian Provinces of Alberta and British Columbia, and promotes the use of uniform truck safety inspection standards developed in cooperation with BMCS and RSPA.

However, violations of laws and regulations governing the transportation of hazardous materials are often treated differently from State to State and among different agencies in the same State. In about half of the States, inspectors have enforcement powers and can issue citations for violations. In the other half, inspectors can only report violations to a separate agency empowered to enforce regulations and assess penalties. Some States provide only for civil penalties; others give the enforcing agency the option of civil or criminal penalties depending on the severity of the violation and the violator's record. In some States, the policy is to issue written warnings to first offenders, while others use more stringent measures. Fines for similar violations also differ among the States.[26]

Enforcement officers report four problems commonly encountered in prosecuting hazardous materials violations. First, due to a lack of training or experience, officers often do not provide adequate documentation in the inspection report or have not followed correct procedures. As a result, many cases are set aside or the charges reduced. Second, enforcement officers find that many judges and local prosecutors have difficulty understanding hazardous materials regulations and respond by dismissing cases or lowering penalties without cause. A third problem is in obtaining assistance from other agencies in preparing evidence for court proceedings. State agencies are sometimes unwilling to cooperate in testing hazardous materials or in providing other technical assistance. In some instances, State facilities may be willing to help, but they cannot provide certain kinds of tests or technical analyses, or they cannot do so in a timely manner.[27] Fourth, State enforcement agencies complain that fines are too low to serve as a deterrent to noncompliance. Many carriers and shippers treat fines as a cost of doing business.[28]

State Training Programs

Although training programs sponsored by the Federal Government have increased the number of State inspectors trained in hazardous materials, there are still disparities among the sizes and capabilities of State inspection forces. Three examples of strong State enforcement training programs are described in box 5B. However, few other States have such extensive training programs. Moreover, training for local enforcement officers is limited. In some States, local officers attend State police academies, but they may not receive hazardous materials training.

According to the 1985 SHMED survey of 47 States, 36 States conduct hazardous materials train-

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[24] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, March 1986), p. 22.

[25] Inspection procedures were based on Motor Carrier Safety Assistance Program guidance in 25 States, on Commercial Vehicle Safety Alliance guidance in 21 States, and on Research and Special Programs Administration guidance in 6 States. Fourteen States indicated that they developed their own procedures. U.S. Department of Transportation, State Hazardous Materials Enforcement and Development (SHMED) program, Hazardous Materials Enforcement Survey, results summarized in the State of New Hampshire, Department of Safety Report, Sept. 30, 1985. The survey was compiled at the spring 1985 SHMED Conference in Charleston, WV.

[26] U.S. Congress, op. cit., p. 23.

[27] Captain Richard Landis in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on State and Local Activities in Transportation of Hazardous Materials," unpublished typescript, May 30, 1985.

[28] National Conference of State Legislatures, *Hazardous Materials Transportation—A Legislator's Guide* (Denver, CO: 1984), p. 36.

Box 5B.—Case Studies of State Training Programs

Several States have developed notable enforcement training programs. The following case studies illustrate some of the achievements of California, Maryland, and Illinois.

California.—The California Highway Patrol (CHP) conducts a comprehensive State training program, during which uniformed CHP inspection officers attend a 20-week basic law enforcement training course on hazardous materials inspection procedures at the CHP Academy. Officers are then assigned to field commands where they receive 30 days of training from veteran CHP inspectors. In addition, officers receive periodic refresher training throughout the year at their field headquarters and return to the academy every 3 years for in-service training. CHP officers assigned exclusively to commercial enforcement duties at inspection and scale facilities and on mobile units are selected from veteran inspection officers. They attend an 80-hour commercial enforcement class at the academy, with retraining every 2 years. Civilian inspectors assigned to CHP inspection duties must have at least 1 year of experience in the maintenance of heavy-duty commercial vehicles. They attend the 80-hour enforcement class at the Academy and receive additional in-service training every 2 or 3 years. CHP also provides training for other State agency personnel involved in hazardous materials management and for employees of the regulated industries. Two-day hazardous materials seminars are conducted as needed for these groups.[1]

Maryland.—Maryland has developed a well-trained inspection force. The State has fully utilized the Transportation Safety Institute's (TSI) outreach activities, sponsoring three courses with about 50 students enrolled in each. The first group of officers to be trained were drawn from select units of the State Police Truck Enforcement Division that patrols major Interstate highways. After the officers had completed the course conducted by TSI onsite in Maryland and were ready for field work, they received 2 months of on-the-job training under the supervision of Federal hazardous materials inspectors from the Bureau of Motor Carrier Safety and the Research and Special Programs Administration. During this time, roadside inspections were performed, but only warnings, not citations, were issued. State officials used this grace period to contact the Maryland Motor Truck Association and major independent truckers to inform them of Maryland's hazardous materials regulations and enforcement program and to solicit voluntary compliance. Maryland officials feel the grace period enabled novice inspectors to gain experience and allowed hazardous materials carriers time to adjust to the new regulatory requirements.

Illinois.—Before 1977, Illinois had no central regulatory agency responsible for hazardous materials transportation and no State enforcement program. Once a study identified these deficiencies, the legislature authorized the Illinois Department of Transportation (IDOT) to regulate the transportation of hazardous materials on the highways and gave the State Police enforcement power. Training of State Police officers was a key component in the enforcement program. Initially, 32 officers were trained in basic hazardous materials inspection and cargo tank inspection at TSI in Oklahoma City. As the State program developed, IDOT set up its own 3-week basic training program, supplemented by regularly scheduled refresher courses. Both the basic training and refresher courses focus on the regulations, procedures for conducting inspections, and methods of preparing a case for prosecution. During training, case studies are presented to demonstrate successful and unsuccessful techniques. Training also emphasizes use of standard equipment issued to on-the-road inspectors for detection and recording of violations, and for personal safety, such as cameras; binoculars; vehicular-mounted detection and surveillance apparatus; explosive meters; and protective footgear, coveralls, and masks. IDOT attorneys and industry representatives participate in the training program to ensure that as many affected parties as possible are kept informed.[2]

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[1] U.S. Department of Transportation, "SHMED Program Workshop Proceedings," unpublished typescript, 1983, p. 126.

[2] U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials: State and Local Activities*, OTA-SET-301 (Washington, DC: U.S. Government Printing Office, March 1986).

ing. The DOT/FEMA survey found that training for compliance or enforcement, including courses that combined compliance, enforcement, and/or response training, is offered by State and local governments in 38 States and the District of Columbia.*

The SHMED survey also found that of the 36 States that conduct training, 32 offer basic hazardous materials compliance and enforcement courses. Other course offerings include cargo tank compliance, radioactive materials, and advanced hazardous materials training. However, 31 States indicated that existing hazardous materials training was not adequate to meet their needs. Four areas where additional training is needed were identified: radioactive materials, hazardous wastes, cylinders, and explosives.

Another finding of the SHMED survey was that 31 of 36 States use the three-phase training course format developed by TSI. Moreover, through TSI, train-the-trainer networks have been established to further Federal training within States; California, Delaware, Idaho, New Hampshire, South Carolina, and Vermont now offer train-the-trainer courses.

A recently established network of trainers is the National Alliance of Hazardous Materials Instructors, an organization affiliated with CVSA. The National Alliance, formed in November 1985, was initiated by personnel who attended TSI train-the-trainer courses and who were experienced in hazardous materials transportation inspections and enforcement. The National Alliance plans to function as a trainers' network with the aim of disseminating information on hazardous materials transportation, providing uniform enforcement and inspection training, and developing expertise on hazardous materials transportation regulations.[29]

A desire to participate in regional training has also been expressed by 43 States. According to the SHMED survey, 23 States indicated that they were already involved in informal regional training, and 27 States said that they made their training courses available to other States. For example, although New Jersey was not a SHMED State, its enforcement officers participated in Maryland SHMED training programs. Funding for enforcement training is provided by the Federal Government or the States, or some combination thereof. Most States (32 out of 36) indicated that they do not charge a fee for their training courses.

Some States have also taken steps to educate shippers and carriers within their jurisdictions. As a matter of policy, Maryland regularly informs the trucking industry about regulations and enforcement practices. The State Police there have developed a training program for commercial carriers, and officers hold frequent meetings with industry groups. Whenever an inspector cites a truck for a violation, the State Police department sends a copy of the traffic safety report to the Maryland Truck Association for forwarding to the truck company. In this way, the company is notified of the violation in time to take whatever corrective action may be needed on other trucks in their fleet.[30] The California Highway Patrol offers self-inspection and compliance seminars at no cost to participating companies. In addition, through its registration program, California is able to notify shippers and carriers of changes to the hazardous materials regulations. Illinois postponed implementation of its enforcement program for 2 years to allow industry to assimilate the regulations and move toward voluntary compliance. Compliance training for the trucking industry is also offered by State Police in New York and New Hampshire.[31]

Conclusions and Policy Options for Enforcement Training

The number, frequency, and variety of hazardous materials shipments by all transport modes and the importance of preventing potential environmental and health damage make essential strong

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*Differences in methodology and data between the State Hazardous Materials Enforcement Development (SHMED) and U.S. Department of Transportation/Federal Emergency Management Agency (DOT/FEMA) surveys resulted in somewhat different findings. For example, while the SHMED data shows that Michigan and West Virginia provide training, agencies from those States did not participate in the DOT/FEMA survey. In addition, only response training was identified for some States in the DOT/FEMA survey, even though the same States responded positively to the SHMED survey; these States include Georgia, Kansas, Kentucky, Florida, and New York. Because of these inconsistencies, the Office of Technology Assessment is using the results of the SHMED survey, which are more complete.

[29] Sergeant John Currie, National Coordinator, National Alliance of Hazardous Materials Instructors, personal communication, Nov. 5, 1985; and statement of Paul R. Henry, President, Commercial Vehicle Safety Alliance to the State Hazardous Materials Enforcement Development Workshop, Salt Lake City, UT, August 1983.

[30] Maryland Department of Mental Health and Hygiene, "SHMED Quarterly Report, April-June 1984," unpublished report filed with the U.S. Department of Transportation, 1984.

[31] U.S. Congress, op. cit., p. 24; and National Conference of State Legislatures, op. cit., p. 72.

Federal and State inspection forces and adequate training of those forces. Despite the need, DOT inspection and enforcement teams have been significantly reduced in size over the past 5 years, and Federal inspectors visit only a small fraction of the total number of shippers, carriers, and container manufacturers in a given year. Furthermore, appropriations for increased numbers of Federal enforcement personnel have not been forthcoming.

Federal inspection and enforcement forces are well trained but limited in number, making State enforcement activities very important for all modes, but particularly for highway transport. Some Federal training programs, particularly those sponsored by DOT, are directed at improving State capabilities. However, despite increased Federal training assistance, State inspection forces still vary greatly in size and skill, and States indicate a clear need for additional training, especially for enforcement of regulations governing radioactive materials and hazardous wastes.

The SHMED program assisted many States in developing consistent enforcement training programs, using successful and relatively inexpensive training methods such as train the trainer. Additional enforcement training courses for State and local employees, provided by RSPA at DOT's Transportation Safety Institute and State locations, have also been valuable. **OTA finds that the hazardous materials enforcement training and train-the-trainer courses taught by TSI provide good models for the development of State programs. The TSI program is a valuable resource, providing standardized training course development; it deserves continued support. In addition, DOT, EPA, and NRC could make existing training courses and materials on hazardous wastes and radioactive materials available to State and local governments in need of them.**

However, financial support for inspection and enforcement programs, including training, is needed according to State and local officials contacted by OTA. Several options for additional financial assistance are available to Congress. **Funding for the SHMED program could be extended so that the program could be made available to those States that have not yet participated and wish to develop hazardous materials enforcement teams with multimodal expertise.**

Direct financial support for inspection and enforcement activities undertaken by local jurisdictions could also be considered. Currently, some local jurisdictions collect permit or license fees from carriers of hazardous materials to fund their enforcement programs. Another option would be to ensure that a portion of the funds provided to the States be directed to those localities that have or would like to develop enforcement capabilities. State and local governments might also be encouraged to develop joint training programs; local law enforcement officers could participate in TSI courses given at State agencies, and State inspectors that participate in train-the-trainer programs could work with local governments.

The specialized expertise required for inspecting container manufacturers indicates that responsibility for such activities might best be left with the Federal inspection forces. **Current levels of inspection and enforcement in this area are not adequate. Congress might consider increasing funding levels for DOT's enforcement program.**

PART II: EMERGENCY RESPONSE ACTIVITIES AND TRAINING

Developing hazardous materials emergency response capabilities so that communities across our large and diverse Nation feel adequately protected is a formidable task. The identification of available training programs, in the survey by the Department of Transportation and the Federal Emergency Management Agency, is a preliminary step toward developing a national strategy for improving emergency response training. While this survey and numerous other studies of training programs document a spectrum of public and private training courses, defining the needs of both first responders and advanced response personnel and establishing a systematic approach to meeting those needs are tasks yet to be undertaken.

Historically, Federal emergency management assistance programs for States and communities, administered by FEMA, have been largely directed at improving civil defense and natural disaster preparedness. However, despite common elements, planning for a hazardous materials accident and for nuclear attack are quite different. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 provides the authority for Federal emergency response, and well-trained Federal emergency response teams are available to assist when major hazardous materials disasters occur. However, little Federal action was taken until after the 1984 tragedy in Bhopal, India, to assist in the development of local response capabilities for the day-to-day risks posed by hazardous materials in communities.

Development of coordinated and comprehensive emergency response capabilities at the State and local levels has been hampered in the past by disinterest or low awareness; more recently, lack of funding and the fragmentation of responsibility and authority at the Federal, State, and local levels of government have proven difficult obstacles to overcome. However, documentation of the connection between the involvement of hazardous materials in a fire or accident and injury rates can trigger the development of training programs for emergency personnel. For example, in Ohio, after a computerized fire reporting system identified a significant number of injuries to fire personnel responding to emergencies involving hazardous materials, the State developed a special hazardous materials training program for firefighters.[13]

Jurisdictions that have experienced serious hazardous materials accidents or have large chemical plants are likely to be directly concerned about developing and maintaining local emergency response capabilities. However, communities of all sizes are becoming aware of the dangers associated with the use and transportation of hazardous materials and are looking for ways to lower their risks. While large metropolitan areas may already have specially trained and equipped teams, in rural communities hazardous materials emergency response usually is an additional duty assigned to the fire or police department. A 1985 FEMA survey of 3,107 local emergency management organizations indicates that transportation accidents involving hazardous materials are major concerns of local governments (see table 5-7),[12] since serious injuries or fatalities may occur if responders lack appropriate training.

Emergency response training is offered by the Federal Government, States, local jurisdictions, industries involved in the manufacture or transport of hazardous materials, professional associations, and educational institutions. However, this diffuse shouldering of responsibility has resulted in emergency response training that varies widely in content and quality and often does not reach those most in need of it, rather than in comprehensive coverage and nationally accepted, standardized levels of training.

Federal Emergency Response Activities

Federal emergency preparedness and response is coordinated by the National Response Team (NRT) under the National Oil and Hazardous Substances

Table 5-7.—The Ten Hazards Perceived as Most Significant by Local Jurisdictions

Hazard	Number of jurisdictions
1. Nuclear attack	a
2. Hazardous materials—highway incident	2,791
3. Winter storm	2,569
4. Flood	2,206
5. Hazardous materials—rail incident	2,188
6. Tornado	2,162
7. Hazardous materials—stationary incident	2,026
8. Urban fire	1,877
9. Wildfire	1,519
10. Hazardous materials—pipeline incident	1,509

[a] All jurisdictions are subject to the effects of nuclear attack.

SOURCE: Jurisdiction responses to Federal Emergency Management Agency, Hazardous Incident Capability Assessment Multi-Year Development Plan, 1985.

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[12] Federal Emergency Management Agency, *Hazard Identification, Capability Assessment, and Multi-Year Development Plan (HICA/MYDP)* (Washington, DC: spring 1985).

[13] The reporting system found that 116 injuries in a single year were incurred at hazardous materials accidents. Chief Don Ryan, Ohio Fire Academy, Hazardous Materials Bureau, personal communication, Apr. 8, 1986.

Contingency Plan.[34] Composed of representatives of 12 Federal agencies with major environmental and health responsibilities, NRT is chaired by the Environmental Protection Agency; the U.S. Coast Guard serves as vice-chair.[35] Thirteen Regional Response Teams formed by regional representatives of NRT agencies and States, provide the regional mechanism for emergency response planning and for coordinating technical assistance during response actions. If State and local governments cannot handle a severe hazardous materials facility or transportation accident or request Federal intervention, EPA and the Coast Guard will assume control and direct Federal emergency response activities.

EPA has also established an Environmental Response Team based in Edison, New Jersey, that has provided various degrees of management or technical support for more than 500 incidents since 1978. The Environmental Emergency Response Unit is a highly specialized technical team sponsored by the Environmental Response Team and other EPA offices that is available to provide onsite assistance. In addition, the Coast Guard operates and maintains Strike Teams on the Atlantic, Pacific, and Gulf coasts for emergency response activities. The Strike Teams have sophisticated equipment for containing, skimming, and removing oil. The Coast Guard also operates the National Response Center for DOT as the point of contact for transportation releases of hazardous materials. During hazardous materials emergencies, scientific advice is provided to the Coast Guard by the National Oceanic and Atmospheric Administration's special hazardous materials group in Seattle, Washington.

While DOT's Research and Special Programs Administration does not respond to hazardous materials transportation accidents, it publishes and distributes the most widely available response information resource, the *Emergency Response Guidebook*.[36] The *Guidebook* contains basic response and first aid information for those who are first to arrive at the scene of an accident and who have not received extensive hazardous materials training; identification numbers that must be marked on packages and bulk containers correspond to the information in the *Guidebook*.[37]

In case of radiological accidents, primary Federal responsibility is shared by FEMA, NRC, DOE, and DOT. These agencies and others are represented on the Federal Radiological Preparedness Coordination Committee, an organization formed in 1982 by FEMA.[38] The Coordinating Committee has 10 Regional Assistance Committees throughout the country to help State and local governments develop emergency plans.[39] NRC and DOE maintain authority for planning and program development for emergency response, notification, technical assistance and advice, and involvement in response activities for radiological spills.[40] In addition, DOE maintains 30 regional response teams for radiological incidents.*

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[34] The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 expanded the scope of the National Contingency Plan, originally established under the Clean Water Act to address oil spills, to include hazardous substances, 42 U.S.C. 9605. The National Contingency Plan is published in the Code of Federal Regulations at 40 CFR 300.

[35] Other participating agencies include the U.S. Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Interior, Justice, Labor, State, Transportation (the U.S. Coast Guard and the Research and Special Programs Administration), and the Federal Emergency Management Agency. Other Federal agencies, such as the U.S. Nuclear Regulatory Commission, participate on an ad hoc basis.

[36] U.S. Department of Transportation, *1984 Emergency Response Guidebook*, DOT P 5800.3 (Washington, DC: 1984).

[37] However, first responders must be trained to use the U.S. Department of Transportation (DOT) *Guidebook* properly. For example, on Oct. 15, 1982, an accident in Odessa, DE, between a pickup truck and a tank truck resulted in a rollover of the tank truck and the release of 150 gallons of divinyl benzene (DVB), a moderately toxic material when inhaled. The truck carried a "combustible" placard. Approximately 100 emergency response personnel eventually responded to the accident, but only some had previous experience or training in handling a hazardous materials accident. The emergency responders who consulted the DOT *Guidebook* to determine appropriate procedures followed the instructions for divinyl ether, the only "divinyl" entry, because DVB was not listed by name; the correct procedure would have been to follow the instructions for combustible materials. The lack of training in this case resulted in injuries to 48 emergency response personnel.

[38] See 44 CFR 351, 47 F.R. 10759, Mar. 11, 1982.

[39] The Federal Radiological Emergency Response Plan (FRERP), 49 F.R. 35896, Sept. 12, 1984, covers any peacetime radiological emergency occurring within the United States that could require a significant response by several Federal agencies. Emergencies at nuclear facilities and during the transportation of radioactive materials fall within the scope of the plan. FRERP was published as an operation plan on Nov. 8, 1985 (50 F.R. 46542) along with concurrences by each of the 12 agencies that participated in its development. A guidance document for State and local government emergency response planning for the transportation of radioactive materials has also been published by FEMA; see Federal Emergency Management Agency, *Guidance for Developing State and Local Radiological Emergency Response Plans and Preparedness for Transportation Accidents*, FEMA-REP-5 (Washington, DC: March 1983).

[40] A Memorandum of Understanding between the Federal Emergency Management Agency and the U.S. Nuclear Regulatory Commission was published on Apr. 18, 1985 (50 F.R. 15485).

State and Local Emergency Response Activities

State authority for hazardous materials emergency response is, like that of the Federal Government, fragmented; it may rest with a State fire marshal's office or State departments of health, transportation, environment, radiological affairs, or civil defense—or, more likely, a combination of some or all of these. Just as the statutory authority for emergency response varies from State to State, so does the interest emergency response generates within the State government. States that are highly industrialized, heavily traveled, confronted with exceptional hazards (such as a large number of waste disposal or nuclear facilities, or a heavy concentration of chemical industries), or have experienced a serious hazardous materials accident are more likely to encourage and support the development of emergency response planning and training and attempt statewide coordination. Emergency response planning is discussed in appendix C.

Because they are convinced that State assistance may be the best or even the only way of protecting rural areas in hazardous materials accidents, some States, including Delaware, Indiana, Oregon, and Tennessee, are developing statewide emergency response plans. For example, the Tennessee Emergency Management Agency (TEMA), in an effort to assure rural areas of adequate hazardous materials emergency response, divided the State into six districts, each with a district coordinator and equipped with a special response van. The district coordinators are trained by the TEMA training institute and must be recertified for hazardous materials response every 2 years. Their multiple responsibilities include training responders in their districts. As a result, Tennessee has more than 2,000 State-certified hazardous materials responders.[41]

Photo credit: Hazardous Materials Bureau, Ohio State Fire Marshal's Office

Training for hazardous materials response includes learning how to don and secure personal protective equipment.

The same factors that influence State emergency response development also operate at the local level, and communities with emergency response capabilities have set up a wide variety of response systems. In rural communities, responsibility for hazardous materials emergency response usually lies with the fire or police department. In contrast, in major metropolitan and urban areas, many public safety officers, primarily firefighters and emergency service organizations, have developed or are developing special competence to respond to hazardous materials accidents. These areas are usually transportation hubs and major manufacturing centers that handle large movements of industrial raw materials, gasoline, and fuel oils. Figure 5-1 shows hazardous materials teams, identified by a study performed by the International Association of Fire Chiefs.[42] Many of these teams are located in regions of the country where there are heavy concentrations of chemical plants and transportation corridors (see figure 5-2).

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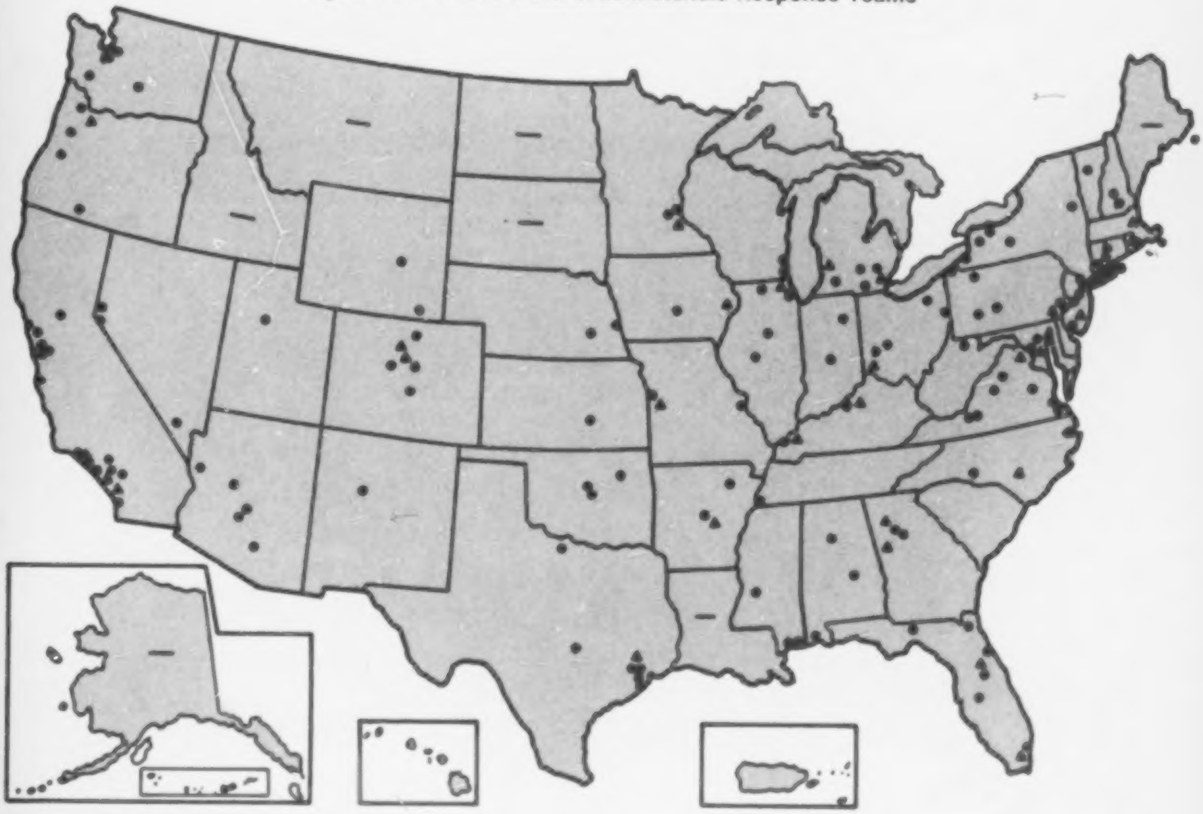
*Other U.S. Department of Energy and U.S. Department of Defense response teams, primarily responsible for nuclear weapons incidents, are available to provide assistance for other accidents involving radioactive materials.

[41] George Kramer, Hazardous Materials Instructor, Tennessee Emergency Management Agency, personal communication, Nov. 26, 1985.

[42] International Association of Fire Chiefs survey of local response teams, July 1985.

Figure 5-1.—Public Hazardous Materials Response Teams



▲ - County response teams
● - City/town response teams

SOURCE: International Association of Fire Chiefs (IAFC) survey and OTA Staff.

Local governments often find it difficult to justify the expense of specialized equipment, training, and manpower for events that occur rarely. Response teams in metropolitan areas are usually financed by general revenues or permit and fee systems; training and equipment may also be provided by industry. The hazardous materials team of the Houston fire department was organized in 1978 using a $7,000 grant from the city and a renovated truck; local industry initially sponsored training for the team. Within a year, the team had developed sufficient expertise to provide basic training for fire department personnel. Industry continues to provide specialized training for tank trucks and railcars, and donates equipment for demonstration purposes. In 1986, the city of Houston budgeted $98,000 for the hazardous materials team in addition to salary and equipment maintenance expenses.[43]

A series of incidents involving hazardous materials prompted the development of a special hazardous materials response team 6 years ago in Santa Clara, California. With support from the Chamber of Commerce, the fire department surveyed fixed facilities to determine the type and volume of hazardous materials stored in the county. A license and fee system based on the inventory information was established to support hazardous materials training for paid and volunteer firefighters and purchase equipment. Three chemists are now employed by

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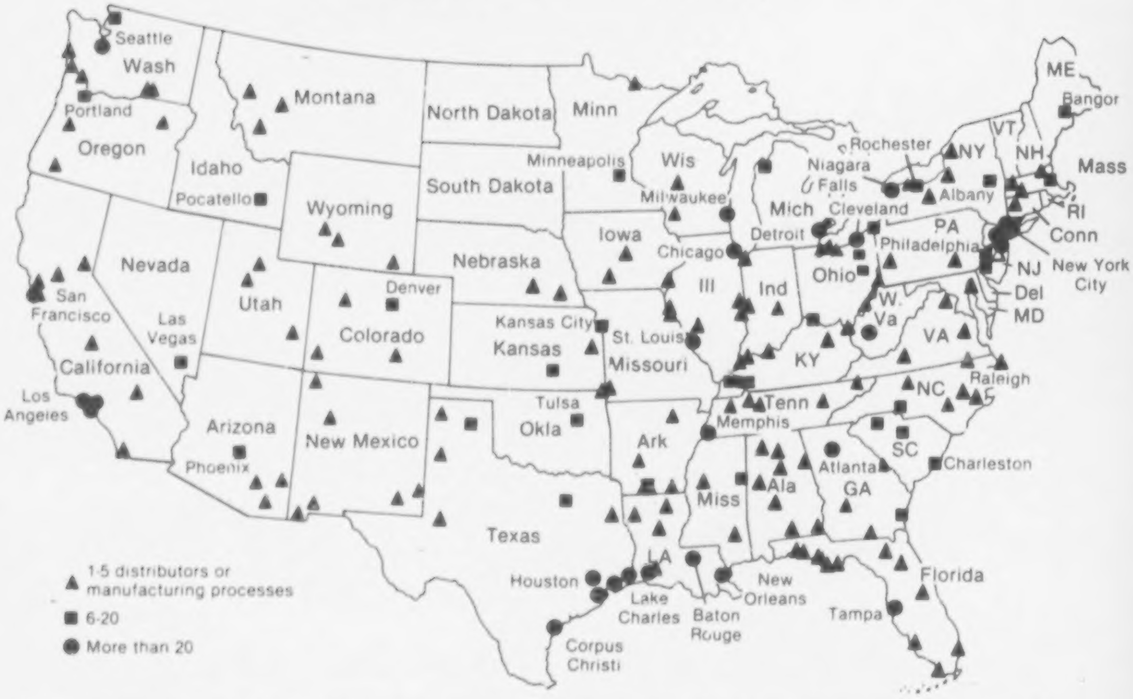
[43] Max MacCrae, Chief, Hazardous Materials Teams, Houston Fire Department, personal communication, Apr. 28, 1986.

Figure 5-2.—The Chemical Plants: Where They Are
(places where very toxic chemicals are handled)



SOURCES: Environmental Protection Agency, SPN Directory of Chemical Producers, Chemical Week Buyers Guide, Chemsources U.S.A., Individual Chemical Companies

the fire department to conduct the training courses and to educate local businesses on the proper storage and handling of chemicals.[44]

Small urban and rural areas are much less likely to have the resources or the experienced manpower to respond appropriately to hazardous materials accidents and are less likely to be aware of the dangers of these accidents. The need for training in these areas seems less pressing, because hazardous materials transportation accidents are less likely to occur. However, when an accident does occur, the lack of trained personnel escalates the risk at the site and within the surrounding community.

Developing and maintaining a regional hazardous materials response team is a cost-effective possibility for smaller jurisdictions. Coalitions of several communities or of industry and local government may be able to provide specialized equipment and response capabilities even for areas with severe financial constraints. Industry participation may lessen the cost to local communities and provide a level of technical expertise in hazardous materials handling, chemical knowledge, and personnel protective equipment that is often beyond local capabilities. The cost of emergency response equipment and the difficulties faced by those who must select such gear are discussed in box 5C.

Industry Emergency Response Activities

Over the past decade, hazardous materials manufacturers have evaluated their safety programs and often taken steps to address their own and the public's concerns. Industry's involvement in hazardous materials emergency response ranges from technical assistance to specialized response teams. The best

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[44] The 1986 budget for the chemical division of the Santa Clara Fire Department, generated by the license and fee program, is $286,000. Larry Monette, Santa Clara Fire Department, Santa Clara, CA, personal communication, Apr. 28, 1986.

Box 5C.—Emergency Equipment

Emergency response equipment is the primary protection and defense for first responders handling hazardous materials. The equipment must be adapted to a particular hazard in that it must be made of materials that are resistant to the hazardous chemical; and it must protect those areas and functions of the human body susceptible to the hazard.[1]

The lack of useful information on the appropriate type of personal protective equipment and procedures for its use is a major concern for local governments and emergency service personnel. Indeed, firefighter gear is only now being tested for chemical resistance. Firefighters and hazardous materials response teams currently rely on fire service literature, manufacturers information, and accumulated personal expertise when selecting chemical protective gear. However, if a community identifies the hazardous materials manufactured, stored, and transported through its jurisdiction, equipment selection can be made based on this information.

The appropriate choice among the varieties of equipment offered and the numerous operating procedures available depends on the hazardous materials being handled, and those responsible for equipment purchase are faced with difficult and expensive options. The factors to be considered prior to purchasing protective clothing include: the initial cost of the clothing; chemical protection capabilities of the construction material; ease of testing, use, maintenance, and decontamination; and durability and reliability of the suit.[2]

Personal protective equipment is currently made of a variety of materials that differ in terms of chemical resistance and durability. Butyl rubber, polyvinyl chloride, and vitron are the three most common materials used:[3]

- Butyl rubber is resistant to gas permeation and can be used with almost anything except chlorinated, aliphatic, or aromatic solvents.
- Polyvinyl chloride is considered excellent for use with acids and bases, and is also good for use with most organics except chlorinated and aromatic solvents. However, it allows some permeation by organics and retains some absorbed material.
- Vitron is resistant to most organics including chlorinated hydrocarbons and solvents except oxygenated solvents, such as alcohols, aldehydes, ketones, esters, and ethers.[4]

The cost of protective suits ranges from less than $100 for a disposable coverall to approximately $2,000 for a chemical splash suit with inner and outer suit protection. Self-contained breathing apparatus, important for incidents involving unknown chemicals or known highly hazardous chemicals, may cost $1,400 each.

Equipment must fit properly, be used correctly, and be maintained appropriately if it is to provide effective protection. In the course of their activities, firefighters and other emergency responders will be exerting themselves, altering the fit and possibly reducing the effectiveness of clothing and respirators. For these reasons, emergency responders must be provided with training and explicit guidelines on the purchase, use, and maintenance of protective equipment.

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[1] A.D. Little Co., "Protective Clothing and Equipment," *Chemical Hazard Response Information System (CHRIS) Response Methods Handbook* (Washington, DC: U.S. Coast Guard/U.S. Department of Transportation, December 1978), p. 7-1.

[2] Proceedings of a meeting of Federal and local officials sponsored by the U.S. Fire Administration, Federal Emergency Management Agency, and Public Technology Inc., unpublished typescript, Washington, DC, August 1984.

[3] International Society of Fire Service Instructors, Chemical Encapsulating Suit Committee, unpublished survey, June 1985.

[4] U.S. Environmental Protection Agency, Edison, NJ, unpublished emergency response training information, January 1986; and A.D. Little Co., op. cit.

known effort is the Chemical Transportation Emergency Center (CHEMTREC), established in 1970 by the Chemical Manufacturers Association (CMA). CHEMTREC maintains an online database on the chemical, physical, and toxicological properties and health effects of the thousands of products of the member companies. CHEMTREC staff provide chemical information for use in onsite decisionmaking and notify the manufacturer of an accident involving its product. CMA has also developed CHEMNET, a mutual aid network of chemical shippers and for-hire contractors, to advise and assist at chemical spills during transportation. Figure 5-3 shows locations of CHEMNET emergency response teams.

Many large petrochemical and chemical manufacturers train and maintain company emergency response teams for both their fixed facilities and transportation accidents. A team may respond itself to a report of an accident involving a company product or, under formal agreements, may request another participating company closer to the incident to respond. Industry teams observed by OTA are instructed to defer to the local on-scene commander at an accident, so that the emergency response effort remains coordinated.[45]

A recent effort, the CMA's Community Awareness and Emergency Response Program, encourages industry and community cooperation in the development of emergency response plans. A successful example was an evacuation drill of several Philadelphia neighborhoods located near industrial facilities, sponsored by the city and two chemical companies in October 1985. More than 600 people, out of approximately 2,000 residents, participated in the exercise, and the emergency response plan for the area was revised as a result of the drill.[46]

The Channel industries in Houston, Texas, the Pesticide Safety Team Network, and Chlorep are other examples of emergency response capabilities provided by industry.[47] The Channel industries, a concentration of chemical facilities along the Texas Channel, have extensive mutual aid agreements with each other. By pooling their resources, these industries can assemble 500 firefighters and other trained personnel and equipment, including power generators for rapid response to an accident. Finally, a nuclear power industry group, The Institute for Nuclear Power Operations, has established a voluntary agreement including 42 utilities to provide assistance to another utility in the event of a radioactive materials transportation accident.*

Emergency Response Training

The population in need of hazardous materials emergency response training is widely distributed and varied. A major segment of this population includes paid and volunteer firefighters.* Volunteers comprise 85 percent of the firefighter population, while the remaining 15 percent are paid employees of municipal, county, or local governments.[48] Of this large number of volunteers, it is estimated that 25 percent, or roughly 255,000 firefighters, leave the fire service each year.[49] Police officers are the second largest group involved in emergency response. In small urban and rural areas, police officers may serve both as enforcement officers, checking for violations of hazardous materials and other safety regulations, and as first responders to transportation accidents involving hazardous materials.

In addition, health professionals and civil defense or emergency management personnel may be required at the scene of hazardous materials accidents. There are approximately 400,000 basic emergency

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[45] Shell Oil Co., Mid-Continent Distribution Area, Response Action Team Training, June 1985.

[46] The companies involved were Rohm & Haas and Allied Chemical. Phil Stefanini, Rohm & Haas, Philadelphia, PA, personal communication, Apr. 22, 1986.

[47] Pesticide Safety Team Network and Chlorep are both specialized information and response units formed by manufacturers of pesticides and chlorine products. Like CHEMNET, participating industries respond, coordinate response, or arrange contractor response to transportation accidents involving their products. Lawrence Norton, National Agricultural Chemical Association, personal communication, Aug. 30, 1985.

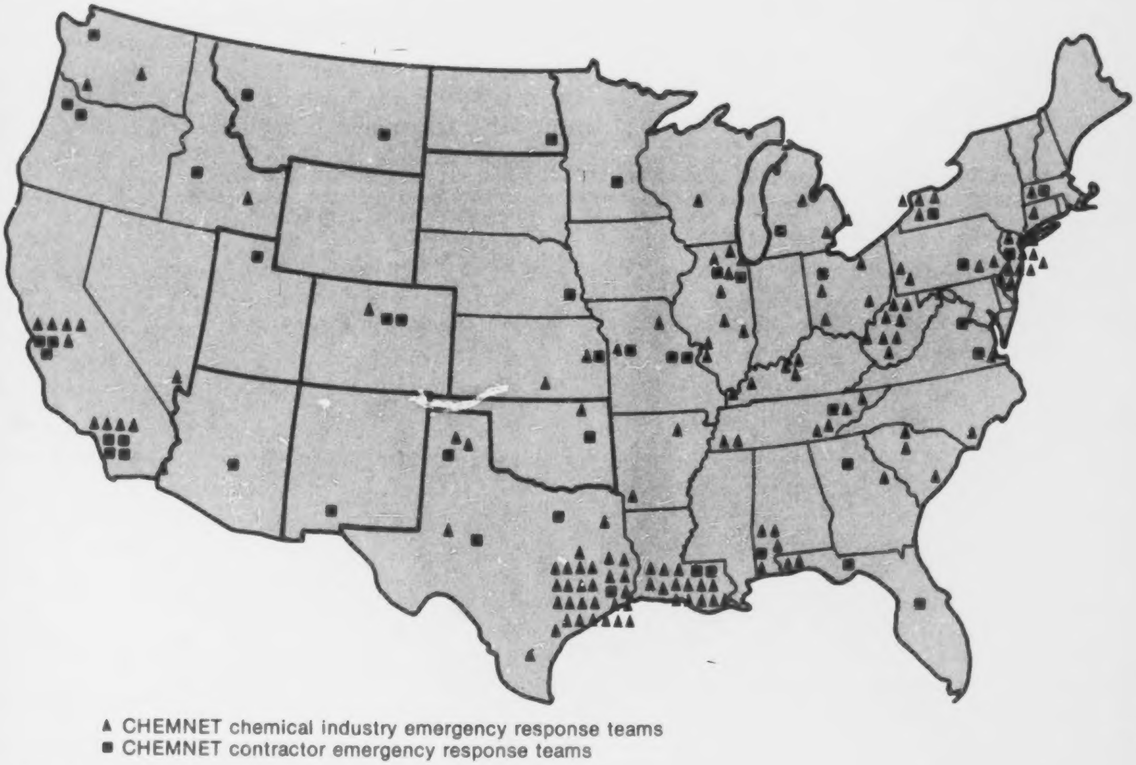
*The Institute for Nuclear Power Operation (INPO) is a nonprofit organization formed by electric utilities in 1979 after the Three-Mile Island accident. INPO establishes industry standards for the operation of nuclear powerplants, including personnel and training standards.

*Call firefighters are part-time paid firefighters who are considered part of the volunteer force for statistical purposes.

[48] As of December 1985, the International Association of Fire Fighters (IAFF) estimated the total fire service population to be 1,034,394 persons. Of this population, 884,600 are volunteers or call firefighters. The remaining 149,794 are paid or career firefighters. The National Fire Protection Association (NFPA) estimates the paid or career fire service population is 226,600 persons and agrees with IAFF figures on volunteer firefighters. Carl Peterson, NFPA, Quincy, MA, personal communication, December 1985.

[49] Chief Warren Isman, Fairfax County Fire Department, VA, personal communication, November 1985.

Figure 5-3.—CHEMNET Emergency Response Team Locations


▲ CHEMNET chemical industry emergency response teams
■ CHEMNET contractor emergency response teams

SOURCE: Chemical Manufacturers Association.

medical technicians,[50] and there are about 6,500 civil defense and emergency management personnel. Employees of State and local public works, environmental health and emergency preparedness agencies, and health care facilities may also be called on to handle hazardous materials emergencies.

Some of these groups have received training in hazardous materials response pertinent to their area of expertise—for example, emergency room physicians and nurses receive training in detoxification procedures, and civil defense workers receive training in radiological response. However, few receive training in hazardous materials response, and many are unequipped to handle victims of transportation accidents or first responders who suffer effects of exposure.[51]

Of this total population, OTA estimates that 1.5 million have not received any hazardous materials training or may be in need of specialized training. Of particular importance is training for the first line of response at a hazardous materials transportation accident—firefighters, police, and emergency medical personnel. What constitutes appropriate response training, who should receive it, and how it should be funded are subjects of intense debate.

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[50] Morando, op. cit.

[51] A survey of New Jersey hospitals conducted by the Workers Policy Project in November 1985, found area hospitals unprepared for chemical emergencies. Of the 32 hospitals surveyed in seven counties in northern New Jersey, less than one-quarter of the emergency rooms had a protocol for chemical emergencies, one-half had a single physician in the emergency room during the daytime, and two-thirds had a single physician in the emergency room at night. Most of the hospitals reported they would be unable to treat more than 20 critically ill patients at one time. Steven Markowitz, et al., *Ability of Health Care Facilities in Northern New Jersey To Respond to Major Chemical Accidents* (New York: Workers Policy Project, November 1985), p. 3; and Stuart Diamond, "Hospitals Found To Be Ill-Prepared for Toxic Spill in New York Area," *The New York Times*, p. A1, Dec. 4, 1985.

Local elected and public safety officials responsible for the safety of the community feel strongly that adequately trained and equipped emergency response personnel are necessary. At a minimum, they believe that first responders must know how to identify hazardous materials, understand the differences between chemical emergencies and standard firefighting, and be able to alert appropriate officials and more sophisticated response teams if necessary.

High-quality training for specialized public and private hazardous materials response teams is also important. Advanced courses generally cover some elements of basic chemistry, the hazardous materials regulations, dangers posed by various chemicals and other commodities, response and cleanup procedures, and the use of specialized protective equipment.

Industry officials maintain that hazardous materials emergency response requires experience and expertise with the commodity involved and that they are in the best position to provide such assistance. However, when hazardous materials accidents occur in locations distant from transportation or manufacturing centers, industry assistance like that of the specialized Federal response teams described earlier is often not readily available.

Federally Sponsored Training

At the Federal level, a myriad of emergency response training programs are conducted by the Federal Emergency Management Agency, the Department of Transportation, the Environmental Protection Agency, the Department of Energy, and the Nuclear Regulatory Commission, among others. These programs, offered at both national and regional locations, are related to different aspects of hazardous materials emergency response, with each agency emphasizing its own area of responsibility. Although representatives of many of these agencies meet regularly as members of the National Response Team, strong Federal leadership in emergency response training has not yet been achieved. In 1985, NRT established a special training committee to identify problems, gaps, and duplicative activities and to recommend training programs and policy alternatives.

The Federal Emergency Management Agency

FEMA hazardous materials training activities include residential and field programs, train-the-trainer courses, and teleconferences. Training is offered by two organizations at the National Emergency Training Center in Emmitsburg, Maryland—the National Fire Academy (NFA) and the Emergency Management Institute (EMI). (See table 5-8.) NFA provides instruction on response tactics and procedures and the chemistry of hazardous materials, while EMI sponsors training that is oriented toward planning and policymaking activities. However, both NFA and EMI training programs only recently began to focus on hazardous materials.

The National Fire Academy trains State and local fire and rescue personnel through both field and resident programs.[52] Most State and local training officials contacted by OTA consider NFA courses and training materials to be extremely valuable. The resident training programs are 2 to 3 weeks in length and offer extensive training; nearly 2,000 students attended hazardous materials courses at the Academy between 1980 and mid-1985.

Shorter versions of the NFA resident training programs have been developed into field training programs; these are 16 hours long, and are designed to be offered in 3-hour segments for evening or weekend sessions for volunteer firefighters. Field training programs generally take 1 year to develop and undergo a 2-year field testing program before becoming final. Two NFA field training programs—"Hazardous Materials Incident Analysis" and "Hazardous Materials Pesticide Challenge"—were reworked into train-the-trainer courses in July 1984. State and metropolitan fire department officials are trained as trainers by NFA and subsequently are provided with instructor guides and student manuals for further distribution.* Between July 1984 and December 1985, these programs reached more than 18,500 students in the field. In addition, an older field pro-

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[52] National Fire Academy training is authorized under the Federal Fire Prevention and Control Act of 1974, Public Law 93-498.

*Metropolitan fire departments are those that serve populations greater than 200,000 people or have a firefighting force of greater than 400, paid and volunteer, and have centralized training.

Table 5-8.—Federal Emergency Management Agency Response Training

Agency and course	Hours per course	Students completing per year
Federal Emergency Management Agency:		
National Fire Academy		
Chemistry of Hazardous Materials	74	300
Hazardous Materials Tactical Considerations	69	300
Hazardous Materials Incident Analysis	16	7,866
Hazardous Materials: The Pesticide Challenge	16	1,475
Recognizing and Identifying Hazardous Materials	3	2,440
Emergency Management Institute:		
Hazardous Materials Contingency Planning	36	80
Integrated Emergency Management Course: Hazardous Materials	36	100
Analysis of Hazardous Materials Emergencies	12	1,158
Hazardous Materials Workshop[a]	8	2,271
Fundamental Course for Radiological Officers	32	1,432
Radiological Monitoring Instructor Course	24	919
Fundamental Course for Radiological Monitors	12	10,805
Radiological Monitoring Refresher Course	4	1,978
Radiological Officer Refresher Course	24	317
Fundamental Course for Radiological Response Team	32	1,368
Hospital Emergency Department Management of Radiation Accidents	9	431
Workshop: Radiological Emergency Preparedness	16	314
Hazardous Radiological Materials Transportation Course	16	256
Special Radiological Defense Seminar	16	208
Radiological Defense Operations Workshop	16	311
Mobile Radiation Monitoring Course	8	62
Radiological Defense Training for Emergency Workers	16	173
Radiological Defense Briefings	8	26
Radiological Emergency Response Organization (Nevada Test Site)	68	270

[a] Hazardous materials workshops are offered by States, with Federal Emergency Management Agency support.

SOURCES: U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986; and Jim Casey, National Fire Academy and Gerald Boyd, Emergency Management Institute, National Emergency Training Center, Emmitsburg, MD, personal communication with Office of Technology Assessment staff, 1986.

gram, "Recognizing and Identifying Hazardous Materials," was recently updated and shortened to 6 hours; 12,440 students were trained under this program from July 1984 to December 1985.[53] Training programs that have been given to State and metropolitan fire departments for train-the-trainer distribution are also available through the National Audio Visual Center.*

While EMI also conducts training programs, the majority of them are directed toward civil defense. Some flexibility is allowed by FEMA for States interested in offering workshops and more in-depth courses on hazardous materials. Indeed, States that receive training funds must use 80 percent of their training monies to send students to 22 specific FEMA courses, only 2 of which deal directly with hazardous materials. Thus, only 20 percent of FEMA funds are available for additional hazardous materials and other types of emergency training.[54] These funding restrictions exist because financial assistance for emergency management provided to States and local jurisdictions by FEMA is authorized under the Federal Civil Defense Act.[55] Funds obligated under this statute may be used to prepare for and respond to actual attack-related events or natural disasters, including manmade catastrophies. However, monies may be used for disaster preparedness "only to the extent that such use is consistent with, contributes to, and does not detract from attack-related preparedness."[56]

Several EMI resident training courses address hazardous materials. One course, "Analysis of Hazardous Materials Emergencies," is a 12-hour basic awareness program conducted by State trainers using EMI materials. Since 1985, when this course was first offered, 1,500 local officials have been trained. Two other courses are geared more towards emergency planning than first responder training. The target audience for one course, Integrated Emergency Management, is local officials; the purpose of the course is to provide an overview of hazardous materials regulations, incident decisionmaking, equipment, evacuation, media relations, and planning exercises. In addition, in early 1986, EMI introduced another hazardous materials planning course directed at State and local officials. The course was developed jointly with EPA and will be offered by both agencies.

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[53] Wayne Powell, National Fire Academy, National Emergency Training Center, Emmitsburg, MD, personal communication, Apr. 14, 1986.

*The National Audio Visual Center in Washington, DC, stores all federally supported audio visual training for publication, distribution, and sale.

[54] Federal Emergency Management Agency, "Draft Fiscal Year 1987 Comprehensive Cooperative Agreement Program Guidelines," unpublished typescript, February 1986.

[55] Federal Civil Defense Act of 1950, as amended, 50 U.S.C. App. 2251.

[56] 44 CFR 302.7; and 44 CFR 312.

In an effort to reach more first responders, FEMA is also sponsoring teleconferences several times a year on different aspects of hazardous materials emergency response. FEMA estimates these broadcasts initially reached more than 100,000 emergency response personnel and firefighters throughout the country.[57] While many officials believe that this type of training is a poor substitute for classroom experience, personnel at the National Fire Academy say that the teleconferences will heighten awareness of hazardous materials for fire service personnel who have little or no training in hazardous materials response. According to FEMA, future teleconferences will focus on exercises that can be used by a community to plan for hazardous materials emergencies.

The Environmental Protection Agency

The Environmental Protection Agency conducts training for hazardous materials response through resident and on-the-road programs. Since the EPA training effort began in 1979, the number of Federal, State, local, and industry personnel trained has risen from 373 during 1979 and 1980 to more than 2,300 in 1985.[58] (See table 5-9.) Resident programs at Edison, New Jersey and Cincinnati, Ohio, include standard courses on decisionmaking, personnel protective equipment for response activities, and hazardous materials incident management. These courses and others are also offered at other sites throughout the Nation.

The Department of Transportation

Training given by the Department of Transportation modal administrations at the Transportation Safety Institute generally covers enforcement and compliance activities rather than emergency response and planning. However, the Coast Guard offers training in emergency response for hazardous materials spills and transportation accidents at its Yorktown, Virginia, Marine Safety School. The training is primarily intended for active and reserve Coast Guard personnel; however, limited numbers of personnel from other Federal, State, and local agencies may attend (see table 5-10).

Emergency response training is also offered by the Federal Railroad Administration through TSI; 1-day seminars for fire and emergency service personnel are offered in locations throughout the United States. In 1984, 50 seminars reached 1,749 students, and in 1985, 84 seminars reached 2,600 students.[59] The Research and Special Programs Administration, which provides numerous hazardous materials compliance and enforcement courses at TSI, has offered emergency response training in the past. These courses were discontinued in 1983, as similar ones were available through FEMA.

In addition, DOT distributes, upon request, copies of its *Emergency Response Guidebook* and a brief guidance pamphlet for first responders.[60] DOT also distributes to every State a self-contained training program on responding to accidents involving radioactive materials.[61] The training program is intended for local fire, police, and ambulance emergency service personnel.

Other Federal Response Training

Other Federal agencies provide limited response training for hazardous materials transportation accidents. The Department of Energy offers emergency

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[57] Joseph Donovan, then Director of the National Fire Academy, Federal Emergency Management Agency, personal communication, Dec. 18, 1985.

[58] Thomas C. Sell, Training Coordinator, U.S. Environmental Protection Agency, personal communication, Dec. 18, 1985.

[59] Frank Fanelli, Office of Safety Programs, Federal Railroad Administration, U.S. Department of Transportation, personal communication, Apr. 2, 1985.

[60] U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau, *Radioactive Materials Transportation Information and Incident Guidance*, DOT/RSPA/MTB-81/4 (Washington, DC: ND).

[61] U.S. Department of Transportation, Research and Special Programs Administration, Materials Transportation Bureau, *Handling Radioactive Material Transportation Emergencies*, DOT/RSPA/MTB-7917 (Washington, DC: July 1979).

Table 5-9.—Number of Students Attending EPA Courses, 1979-85

EPA courses	1979-81					Fiscal year 1982					Fiscal year 1983					Fiscal year 1984					Fiscal year 1985					Cumulative total
	EPA	FED	S/L	IND	TOT	EPA	FED	S/L	IND	TOT	EPA	FED	S/L	IND	TOT	EPA	FED	S/L	IND	TOT	EPA	FED	S/L	IND	TOT	
EPA Training Response Safety Decisionmaking Workshop											34	3	5	4	46	5	8	22	8	43	22	14	57	24	118	207
Incident Mitigation and Treatment Methods	7	5	15	18	45	2	4	20	6	32	22	59	59	29	169	9	34	75	13	131	26	58	189	32	305	682
Sampling for Hazardous Materials						11	3	50	6	70	57	117	19	17	210	30	15	130	17	192	41	30	179	21	271	743
Hazardous Evaluations and Environmental Assessment	11	2	1	3	17	10	3	21	11	45	39	30	5	6	80	38	18	39	9	104	25	16	115	11	170	416
Air Surveillance for Hazardous Materials Assessment																21	24	109	15	169	14	12	151	34	234	403
Personnel Protection and Safety	58	12	43	41	154	125	392	41	23	581	52	74	437	40	605	80	44	347	33	507	102	72	432	36	654	2,501
Hazardous Materials Incident Response Operations	36	44	52	25	157	88	86	95	47	316	67	158	119	36	380	80	177	194	56	505	140	195	236	60	623	1,981
Total students trained per year					373					1,044					1,490					1,651					2,375	6,933

Key:
EPA = U.S. Environmental Protection Agency
FED = Federal Government
S/L = State and local
IND = Industry
TOT = Total

SOURCE: U.S. Environmental Protection Agency.

Table 5-10.—U.S. Coast Guard Emergency Response Training

Agency and course	Course type[a]	Hours per course	Students per year
U.S. Coast Guard Training Center:[b]			
Port Operations Department	CER	320	70
Marine Safety Petty Officer	CER	240	210
Hazardous Chemical Training	CER	80	210
U.S. Coast Guard Headquarters:[c]			
On-Scene Coordinator/Regional Response Team Exercises	R	12	240
On-Scene Coordinator/Local Response Team Training/Exercises	R	12	750
National Strike Force Training	R	16	960

[a] C = Compliance, E = Enforcement, R = Response

[b] Located in Yorktown, VA

[c] Located in various locations established by national and regional response team members

SOURCE: U.S. Department of Transportation and Federal Emergency Management Agency, "Report to the Congress: Hazardous Materials Training, Planning, and Preparedness," unpublished draft, 1986.

response training, in the form of 1-day workshops at DOE regional locations, to State and local police and firefighters.[62] The Nuclear Regulatory Commission offers, through Oak Ridge Associated Universities, two training courses in health physics twice a year. Since 1960, approximately 500 State employees have been trained in "Health Physics and Radiation Protection." A similar course, "Applied Health Physics," is available for Federal, State, local, and industry personnel.[63] Both courses discuss radiation accidents, the role of a health physicist in medical emergencies, personnel decontamination and protection, environmental monitoring, and environmental sample preparation.[64]

State and Local Emergency Response Training

While more State and local officials are aware of the need for hazardous materials response training, a 1985 survey conducted by the National Response Team (NRT) and the Regional Response Teams (RRT) found that response capability varies greatly from State to State. Many State fire academies have recently added hazardous materials training to their curricula and now offer refresher courses for firefighters and other emergency service personnel.[65] Moreover, organized training programs for personnel involved in oil or hazardous materials emergency response were identified in 27 States. These training programs are generally offered by the State fire marshal's office, the State fire training agency, or the emergency preparedness agency.

In addition to State fire academies, other educational institutions also offer hazardous materials response training for State and local personnel. According to the DOT/FEMA survey, more than 500 educational institutions, including community colleges and universities, offer training in hazardous materials response.[68] These institutions are widely distributed and charge only modest tuition fees; but course content and quality varies from institution to institution.

However, factors limiting State and local participation in training courses were also identified by the NRT/RRT survey; more than 80 percent of States indicated that insufficient funding for courses and for travel was an obstacle. Other problems included the lack of appropriate courses available to State and local responders, and the fact that training is often a relatively low priority for State agency managers.[66]

Moreover, the scope and content of State training programs and emergency response personnel requirements are not consistent. Examples of State training activities, discussed in box 5D, illustrate the different types of programs that have been established.

Local training for emergency responders also varies widely, reflecting the relative importance of hazardous materials emergency response in the community or State government and the financial resources available. The spectrum of local hazard-

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[62] Theresa Yearwood, Science Applications International Corp., Oak Ridge, TN, personal communication, March 1986.

[63] Jo Tipton, Registrar, Oak Ridge Associated Universities Professional Training Program, Oak Ridge TN, personal communication, April 1986.

[64] Oak Ridge Associated Universities Professional Training Programs, course outlines for "Health Physics and Radiation Protection" and "Applied Health Physics," sponsored by the U.S. Nuclear Regulatory Commission, Office of State Programs, unpublished typescript, March 1986.

[65] According to the *Directory of State Fire Service Training Systems*, 24 of the 50 States offer some form of hazardous materials training to firefighters, fire officers, or other emergency personnel. These States are: Arizona, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Indiana, Iowa, Kansas, Maine, Massachusetts, Minnesota, Mississippi, Nebraska, New Mexico, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Vermont, and Washington. National Emergency Training Center, *Directory of State Fire Service Training Systems* (Emmitsburg, MD: National Fire Academy, 1982).

[66] National Response Team/Regional Response Teams, "Federal/State/Local Oil and Hazardous Substances Emergency Preparedness Activities," unpublished typescript, July 1985.

Box 5D.—State Emergency Response Training Program

Ohio

In 1976, Ohio developed a computerized fire reporting system. Analysts studying the results noticed that a significant number of emergency response personnel who responded to hazardous materials accidents were being injured.[1] This spurred the establishment of a hazardous materials training program for firefighters. A three-phase training program began in 1978.

1. Phase I is a 4-hour program that covers identification of hazardous materials, placards, labels, and methods for assessing community problem areas.
2. Phase II is an 8- to 12-hour program that deals with containment, patching, personal protection, hands-on training, and other response procedures.
3. Phase III is a simulation of an actual incident in the community, and includes participants from response organizations, local government agencies, and others that might be involved in an accident.

Since 1980, 36,702 firefighters have been trained through 1,637 courses. In 1982, Ohio assisted the National Fire Protection Association in the development of a similar training program for national distribution to other fire services. Ohio has also made special equipment available throughout the State, because many local fire departments are unable to finance such purchases. Five trucks equipped with approximately $60,000 worth of personal protective equipment have been stationed around the State for dispatch to hazardous materials accidents. Support for training development and equipment purchase was initially provided by two highway safety grants totaling $90,000. Continued support of the training and equipment program is now provided by the State at a cost of $400,000 per year.

California

A uniform standard for the training of hazardous materials response personnel, made final in December 1985, by the California State Fire Marshal's Office is one of the first attempts by a State to develop such standards. The standard identifies two levels of hazardous materials technician training; both positions involve in-depth training and knowledge of hazardous materials. A career development guide has been developed for the first level only. Career development guides, which are the basis of the State certification program, provide minimum performance standards for hazardous materials response; list the State training resources available; and are keyed to the National Fire Protection Association Professional Firefighter Qualifications. In addition to course material covered in the classroom, information specific to a locality is also provided. Entrance examinations are required for those seeking to enter the training program.

Virginia

Virginia has developed four levels of training.

1. Level I training, a 16-hour program, is designed for first responders. It covers an introduction to hazardous materials terms and definitions, identification and nature of hazardous materials, use of the DOT *Emergency Response Guidebook* and other resources such as CHEMTREC, and decontamination.
2. Level II training is based on two 16-hour courses offered by the National Fire Academy—Hazardous Materials Incident Analysis and Hazardous Materials: The Pesticide Challenge. An additional 8-hour segment involves hands-on training.
3. Level III training, a 120-hour program, focuses on the activities of an actual response team. A simulation of a hazardous materials accident is included.
4. Level IV training is still under development, but is expected to focus on incident management and emergency planning.[2]

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[1] Ohio State law requires local fire departments and communities to gather information on and report fires and hazardous materials accidents. Data on the incidence of hazardous materials involvement for fixed facilities and transportation accidents, injuries to personnel, and hazardous materials involved were collected. Don Ryan, Hazardous Materials Bureau, Ohio State Fire Academy, Reynoldsburg, OH, personal communication, Apr. 8, 1986.

[2] Joe Thomas, Virginia Department of Fire Programs, personal communication, May 21, 1986.

Michigan

In Michigan, the statewide Hazardous Materials Response Plan, inaugurated in 1983, includes provisions for four levels of emergency response training to be given by State certified instructors or State instructors in conjunction with experienced industry personnel.

1. Level I training is encouraged for firefighters, police officers, emergency medical technicians, health departments, and others who may be first responders. Training covers safe approach, material identification, and communication for assistance; it lasts approximately 2 hours.
2. Level II training, a 4- to 6-hour program, is designed for decisionmakers and covers evacuation, spill containment, and incident management, including establishing emergency operations and dealing with the news media.
3. Level III training for specialized hazardous materials response teams provides additional training in protective equipment, transportation equipment valves and closures, containment techniques, and chemical characteristics. At least 16 hours are required to complete this program.
4. Level IV training, approximately 24 hours, is required for industry emergency response teams that might assist or advise local authorities. Training covers capping, patching, and product transfer procedures as well as coordination with local and State responders.[3]

[3] James L. Burnside and Sarah A. Rowley, "Michigan's Hazardous Materials Response Plan," *1984 Hazardous Materials Spills Conference: Prevention, Behavior, Control and Cleanup of Spills and Waste Sites,* Nashville, TN, Apr. 9-12, 1984.

ous materials training courses ranges from well organized and funded hazardous materials offered by highly trained individuals to little or nothing.[67] Moreover, some local officials feel that State programs do not meet the needs of local jurisdictions.

State officials, in conversations with OTA staff, confirmed that standardization of course materials, more coordination between programs, and better information about available courses are necessary for effective training of emergency response personnel. If State instructors are trained at FEMA's National Fire Academy and State programs are based on FEMA courses and materials, greater course uniformity can be expected. Many State training officers contend that the 3- to 6-hour introductory courses offered by many organizations are too superficial to prepare first responders adequately for hazardous materials transportation accidents.[69] In addition, differing criteria are used to certify courses, instructors, and emergency response personnel. Coordination of training agencies, such as fire academies and educational institutions, within each State, is an important step toward providing more comprehensive and uniform training of State and local responders.

An interactive computer system, currently under development for FEMA, will eventually serve as an electronic bulletin board for State and local emergency response personnel, providing information on FEMA training, appropriate hazardous materials literature, State and local contacts, and summaries of properly handled hazardous materials accidents.[70] While comprehensive training information will not initially be available through this system, it is a step in the right direction. Furthermore, the Secretary of Transportation has announced that DOT will establish an information clearinghouse with a toll-free number. The clearinghouse will supply details on training programs, emergency response teams, planning assistance, and other information to help local communities.[71] Coordination of these two Federal information-sharing efforts is important to ensure their cost-effectiveness.

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[67] Association of Bay Area Governments, *National Directory of Hazardous Materials Training Courses* (San Francisco, CA: March 1985), p. 8; and data supplied by the International Association of Fire Chiefs to the Office of Technology Assessment.

[68] This figure is considered too low by industry trainers, due to underreporting and limited industry participation in the survey. Several well-known industry training programs were not included in the survey. U.S. Department of Transportation and Federal Emergency Management Agency, "Report to Congress on Hazardous Materials Training, Planning and Preparedness," unpublished draft typescript, January 1986.

[69] Training officers in 35 State fire academies, personal communications, June and July 1985.

[70] Users of this system will have access to other materials of interest and will be able to leave messages. FEMA spent $50,000 in 1985 and $60,000 in 1986 for the development of this computer system. Although the system will be available free of charge, necessary hardware, such as a personal computer, must be purchased by participating State or local agencies. William Metz, Argonne National Laboratories, personal communication, Apr. 22, 1986.

Industry-Provided Emergency Response Training

Industry training is provided by individual shippers, manufacturers, and associated trade and professional organizations. Typically, the training covers hazardous materials emergency response for both fixed facilities and transportation accidents through seminars, workshops, and such aids as videotapes and films. However, these training activities are generally limited to larger industries with adequate resources, and current programs reach relatively few local personnel. Moreover, State and local emergency response personnel invited to participate often are restricted to playing themselves in industry training exercises rather than participating in more advanced activities such as unloading a cargo tank. As a result, much of the industry-provided training for emergency response personnel focuses on recognition of hazardous materials, on-scene management, and initial response actions such as spraying foam.

Among the chemical and petrochemical manufacturers that offer hazardous materials training are DuPont, Exxon Chemical, J.T. Baker, Stauffer, Union Carbide, and Mobay.[72] A number of these programs have been opened to neighboring response teams or other interested response personnel. This training varies from 1-day seminars to more extensive hazardous materials training and coordination drills.[73]

Recently, five chemical companies established a $400,000 grant to set up a pilot program in New Jersey to train local emergency response personnel for hazardous materials emergencies. Administered by the Union and Middlesex Counties Hazardous Materials Advisory Council (HMAC), the program includes a slide and tape presentation and a 6-hour training seminar.[74] Between February and May 1986, 16 training seminars were held at local fire department facilities. In addition, 200 copies of the slide and tape presentation are being distributed, free of charge, to appropriate emergency response organizations; other copies may be borrowed from HMAC.

The transportation industry also provides emergency response training. Although most of this training was set up originally for shipper and carrier personnel; however, emergency response personnel are invited to participate. Companies that offer training include Flying Tigers and a number of railroad systems, such as Boston & Maine, Burlington Northern, Chessie Systems, Conrail, Soo Line Railroad, Southern Pacific, Southern Railroad Systems, and Union Pacific Systems.[75]

Industry also provides equipment and teaching expertise for training programs offered by other institutions. For example, Shell, Amoco, and ARCO have contributed equipment used in Texas A&M University's annual tank truck rollover response program.[76] Union Pacific Railroad, in cooperation with EPA, offers a training course in emergency response.[77]

Trade associations offering training in hazardous materials and response procedures include the Association of American Railroads, the American Trucking Associations, the Chemical Manufacturers Association, the American Petroleum Institute, the

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[71] Elizabeth Hanford Dole, Secretary of Transporation, "Remarks Prepared for Delivery to the Chemical Manufacturers Association," delivered in St. Louis, MO, unpublished typescript, May 7, 1986.

[72] Association of Bay Area Governments, op. cit.; and Hazardous Materials Advisory Council (HMAC), "Survey of Industry Emergency Response Training," *HMAC Courier*, vol. 4, No. 10, Dec. 13, 1985.

[73] For example, Union Carbide training through its HELP program lasts for 1 week, while DuPont Chemical training lasts for 4 days. National Response Team/Regional Response Teams, op. cit.

[74] The five companies participating in the grant program are DuPont, Exxon Chemical, American Cyanamid, Merck & Co., and Union Carbide. Under the pilot program, a slide and tape show was developed for first responders while a 1-day seminar was developed for other emergency response personnel. Training materials were produced by the Institute for Life and Safety Technology and Emergency Management of Ashland, MA. Barry D. Bernstein, the Hazardous Materials Advisory Council, Linden, NJ, personal communication by letter, Mar. 27, 1986.

[75] National Response Team/Regional Response Teams, op. cit.

[76] Albert Stirling, Oil and Hazardous Materials Control Divisions, Texas A&M University, College Station, TX, personal communication, Apr. 24, 1986.

[77] Since 1979, Union Pacific Hazardous Materials Training Activities have trained 9,383 employees and 36,106 State and local response personnel. In 1984 alone, "Recognizing and Identifying Hazardous Materials," "Defining Your Hazardous Materials Problem," and special training programs reached over 6,000 response personnel. Charles Wright, Training Director, Union Pacific Systems, personal communication, Apr. 29, 1985, and compiled data on Union Pacific hazardous materials training.

National Agricultural Chemical Association, and the Chlorine Institute. Some State associations also sponsor training programs. For example, the Pennsylvania and New Jersey Motor Truck Associations provide training seminars for State Police in their respective States.

To improve the reliability and breadth of information available for hazardous materials response, the Association of American Railroads has developed an emergency action guide for first responders, and a more detailed information system for technical personnel.[78] These systems include information on the 134 commodities that represent 98 percent of railroad hazardous materials traffic.

Professional associations representing emergency service personnel also offer emergency response training. Training includes basic hazardous materials recognition as well as advanced response procedures. These training programs are often more comprehensive and uniform and may be more readily available than training offered by others in the private sector. The National Fire Protection Association, the International Association of Fire Fighters, the International Association of Fire Chiefs, the International Association of Fire Service Instructors, and the International Association of Chiefs of Police are among the professional associations offering such training.[79]

The National Fire Protection Association (NFPA), responsible for the establishment of minimum professional competence standards for firefighters, inspectors, instructors, and officers, has recently begun to develop standards for hazardous materials response. The NFPA standard-setting process, a consensus approach, involves representatives of diverse groups such as the insurance industry; fire, police, and other emergency service organizations; chemical industry representatives; and Federal, State, and local government agencies. Thus, it usually takes 2 or 3 years until NFPA standards are completed.[80]

Conclusions and Policy Options for Emergency Response Training

Approximately 2 million firefighters, police officers, and other emergency service personnel are potential first responders to hazardous materials transportation accidents. Despite an abundance of courses, appropriate training often does not reach these first responders either because the awareness of the need is too low, funding is not available, or uncertainty exists about the appropriate course. Participants in an April 1985 FEMA-sponsored workshop of national, State, and local experts agreed that it is emergency personnel who are most likely to be first responders that are most in need of training.[81]

Federal expenditures to support emergency response training have placed emphasis on lengthier, advanced level response training courses of the type offered by FEMA at Emmitsburg, Maryland, and EPA at Edison, New Jersey. Such courses are appropriate for personnel that will be part of a hazardous materials emergency response team in an area with an identified high-hazard potential, although these represent a relatively small percentage of the Nation's firefighters.

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[78] The more detailed system, the Industrial Chemical Accident Response Information System (ICARIS), includes four categories of data:

1. *general information:* identification of chemicals including commodity codes (STCC, UN/NA, IMCO), trade names and synonyms, and shipping information.
2. *chemical information:* the chemical properties of the materials.
3. *health and hazard information:* descriptions of health effects, response guidelines, and appropriate protective clothing.
4. *environmental effects information:* compatibility of chemicals, toxicology, and pollution effect data.

ICARIS integrates environmental models with current chemical data to provide real-time assessments of chemical spills and support response decisions by technical staff. ICARIS currently performs three functions: information retrieval, air dispersion modeling, and estimation of chemical properties (e.g., volatility from soil). Gerald A. Meier, Association of American Railroads, "The AAR Chemical Spill Response Information System," unpublished typescript, July 1983.

[79] The National Fire Protection Association provides training to fire and emergency service personnel, primarily through slides, tapes, and instructors guides. National Fire Protection Association, *Fire Service Training Programs, 1985 Catalog* (Quincy, MA: 1985). The National Fire Protection Association also recently developed emergency response training videotapes that can be broadcast via satellite.

In addition, the International Association of Chiefs of Police recently developed a training program on Hazardous Materials Incidents. The Hazardous Materials Incidents training program covers basic requirements for first responders, supervisors, and commanders of hazardous materials incident scenes; on-scene safety precautions; how to establish guidelines for containing hazardous materials; standard development for coordinating multidisciplinary response teams; how to recognize hazardous materials; and how to identify the needs, procedures, and duties of on-scene managers. International Association of Chiefs of Police, *Law Enforcement Training Catalog* (Gaithersburg, MD: 1986), p. 36, and Chuck Peltier, International Association of Chiefs of Police, Gaithersburg, MD. personal communication, Apr. 8, 1986.

[80] Martin F. Henry, Assistant Division Director, Field Services, National Fire Protection Association, Quincy, MA, personal communication, Apr. 15, 1986.

[81] The Federal Emergency Management Agency, National Emergency Training Center, "Proceedings—National Workshop on Hazardous Materials Training," unpublished typescript, October 1985, p. 20.

Photo credit: Research and Special Programs Administration, DOT

Without adequate training, emergency response personnel may enter the accident scene unprotected—a dangerous situation.

OTA concludes that a national strategy to make an appropriate level of hazardous materials response training, whether basic or advanced, available to State and local personnel is urgently needed. The Federal role in developing a training strategy could include: participating in the development of training guidelines, ensuring adequate funding levels, and establishing a training information clearinghouse. While 1.5 million emergency response personnel need additional hazardous materials training, the vast majority require only basic first response training. However, maintaining levels of expertise through refresher courses for those already trained is also important.

Better organization and utilization of existing training resources could increase the numbers trained considerably without additional funds. For example, existing Federal hazardous materials emergency response training and training support programs in FEMA, EPA, the Coast Guard (DOT), NRC, and DOE need to be coordinated and made complementary. However, choosing the right agency to coordinate Federal emergency response programs and administer any special funding program is problematic. Institutionally, that agency is FEMA. The use of FEMA grant monies to support State and local planning and training activities for hazardous materials is limited, however, by the Federal Civil Defense Act, which requires that funds be used primarily for civil defense preparedness. Moreover, while there is widespread agreement about the need for a strong, central Federal leadership role, there is equally widespread doubt about whether FEMA can provide that leadership.

One congressional option is to charge the National Response Team with specific responsibility for coordinating hazardous materials response training and developing national guidelines for courses and levels of training in cooperation with NFPA. Broad-based participation, similar to that in the NFPA process, in developing the guidelines is important. At the Federal level, this would mean that DOT, FEMA, EPA, and probably NRC and DOE would need to reach agreement, a possibility under the auspices of the NRT training committee. This committee has already begun to define both first responder and more specialized target audiences, and identify the tasks and core courses associated with each group. Developing quality control and certification standards for training courses and instructors is also important.

Additional expenditures of $15 to $20 million annually from various public and private sources could support training to large numbers of emergency response personnel. This figure assumes maximum cooperation between Federal, State, and private groups now providing training, and coordinated use of existing training resources including those of industry. Congress might wish to designate a lead agency for developing a direct contract program with the States for funding training. The lead agency could be DOT, EPA, or FEMA, all members of NRT with direct responsibility for training. Funds distributed to States for hazardous materials transportation emergency response training might carry a stipulation that some funds be passed through to local jurisdictions.

The most cost-effective training programs are those that use train-the-trainer techniques. These courses also serve as conduits for programs developed according to nationally accepted guidelines. Congress might consider giving funding priority to States whose training officials participate in Federal hazardous materials training programs, and who subsequently develop State training networks using train-the-trainer courses to improve delivery of training to local emergency response personnel.

In addition, developing a national clearinghouse to make existing information on hazardous materials training available to State and local personnel, both in hard copy and online, would provide an extremely useful service to emergency response forces. The DOT/FEMA survey provides basic training information already in computerized form. Moreover, the interactive computer bulletin board FEMA is developing and the proposed DOT clearinghouse for response information provide a framework for such a service. Several successful programs exist as models, most notably a DOT-sponsored, microcomputer information exchange administered through a university (see chapter 2).

Financing Emergency Response Training

While the SHMED program and MCSAP have provided basic support for enforcement training, emergency response training urgently needs, but has not received, similar Federal attention. The management of the SHMED program provides a model for a cost-effective Federal emergency response training support program. It made good use of existing resources, provided uniform training, used train-the-trainer techniques, and required that States adopt Federal regulations, designate a State lead agency, and participate in funding.

OTA concludes that an annual Federal funding level of $5 to $7 million, over and above monies now being spent, could provide an adequate Federal assistance program, if existing resources are reorganized and tightly managed. Table 5-11 shows an estimate for a basic hazardous materials training program for first responders. This estimate, based on modular training and a per student cost of $100, assumes that trainees are already trained firefighters, enforcement officers, or medical technicians.[82] OTA believes that this Federal funding level is adequate because considerable resources are already devoted to training, a number of sound courses have already been developed, and the type of training required by first responders is not extensive.

Table 5-11.—Calculations for Costs of Hazardous Materials Emergency Response Training for First Responders[a]

Target audience:
First responders—firefighters, police, hospital emergency room staff, and ambulance drivers.
Size of target audience:
1.5 million (approximate)
Nature of training:
Basic training covering identification of hazardous materials, the importance of self protection, protection of the public and environment, and the notification of authorities.
Duration of training:
Modular training geared to appropriate target audiences would be developed and taught by trained instructors. Must provide opportunities for role playing and group problem solving and acquaint response personnel with the unique dangers of hazardous materials response.
Key cost components:
Course development, handout materials/workbooks, instructional services, training personnel, travel, and equipment.
Estimated average cost per trainee:
$100[b]
Estimated trainee completions per year:
150,000 to 225,000
Required annual funding total:
$15 to $22.5 million

[a] This type of training emphasizes the differences between hazardous materials response and firefighting. Training covers the dangers inherent in hazardous materials accidents, how to identify hazardous commodities, appropriate responses, and the application and use of protective equipment. Basic training is not designed to cover advanced hazardous materials response techniques or cleanup procedures.

[b] OTA estimates based on tuition for existing courses and interviews with officials and course instructors. Charges vary widely—one large and successful 2-day program is free, whereas another more comprehensive 3-day course charges tuition of $450.

SOURCE: Office of Technology Assessment.

Possible Federal funding sources for emergency response training include:

- general revenue;
- other Federal funding programs related to hazardous materials transportation, such as the Surface Transportation Assistance Act (the fuel tax), the Nuclear Waste Policy Act, or Superfund; and
- creation of a dedicated fund based on user fees, such as those generated by a permit or registration fee levied against hazardous materials industries.

The fuel tax is the most broad-based of these taxes, and gasoline transport accounts for more dollar damages than all other hazardous materials. Since truck accidents require the most frequent emergency response activities, tapping fuel tax funds to support emergency response training provides for a degree of equity. The Nuclear Waste Policy Act provides some funds for State and local activities related to transportation, but such funds are generated by nuclear utilities, and their shipments represent a small percentage of all hazardous materials shipments. Superfund already has substantial claims against it.

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[82] OTA calculations are based on interviews with emergency response trainers and OTA staff experience with four types of emergency response training: industry, jointly sponsored public and private course for community first response personnel, Federal training for public response, and Federal training for Federal response.

Use of funds generated by a Federal registration or permit program could have major adverse impacts on similar State and local activities (see chapter 4). Moreover, the administrative costs for such a Federal program need to be carefully considered. Furthermore, industry will be more willing to support a new user fee to fund training if it obtains assurances that:

- the amounts assessed relate to the magnitude of local training needs,
- the funds reach those most in need,
- a fixed limit is placed on the amount it must contribute,
- local jurisdictions make maximum use of existing regional resources and participate in the funding effort in some way, and
- no individual State or local fee programs are implemented for this purpose in participating jurisdictions.

Two independent groups have supported the concept of a dedicated fund, generated by user fees levied against shippers and carriers to support State and local hazardous materials program development and emergency response training. The groups are the National Hazardous Materials Transportation Advisory Committee, formed by the Secretary of Transportation, and the Hazardous Materials Coalition, formed several years ago by State and local government organizations and some industry representatives. Arguing against this concept are the facts that many jurisdictions already impose registration or permit fees, using them for a variety of purposes frequently unrelated to emergency response, and that requiring payment of another such fee is unacceptable to many industries.[83] Restrictions on their own fee programs, suggested for jurisdictions choosing to benefit from the Federal fund, may be difficult for States to accept.

Equity in apportionment of funds is an important consideration, although an appropriate basis is difficult to determine. Funds could be apportioned to States on the basis of population or of hazardous materials transportation density. However, areas such as the Gulf Coast, California, and the Pennsylvania, Ohio, Indiana, and Illinois corridor, that have the largest amounts of hazardous materials traffic, also have the largest number of industry response teams. Moreover, the need for emergency response training is often not recognized in small urban or rural areas where the probability of an accident is low, but where the consequences of an accidental spill for untrained response personnel could be severe. In addition, jurisdictions that already have well-developed emergency response capabilities have made it clear that they need financial assistance for maintaining training levels and equipment.

Additional local industry involvement in development and delivery of community hazardous materials emergency response training could be encouraged to defray training costs. Support from Federal and private sources for financial assistance to State and local jurisdictions will be more readily forthcoming if jurisdictions can show that they:

- have developed an emergency response plan;
- know what their training needs are;
- have local matching funds or resources available; and
- have cooperated with neighboring jurisdictions in such efforts as joint planning, information collection, and mutual aid agreements.

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[83] Two major industry groups, the Association of American Railroads (AAR) and the Chemical Manufacturers Association (CMA) have opposed such a fund in the past. CMA is modifying its opposition, requesting further study to quantify the need; AAR remains opposed.

Appendixes

Appendix A

Hazardous Waste Regulation

Introduction

The transportation of hazardous wastes is regulated by both the Hazardous Materials Transportation Act (HMTA) and the Resource Conservation and Recovery Act (RCRA) of 1976. Subtitle C of RCRA, which is administered by the U.S. Environmental Protection Agency (EPA), is the primary Federal statute governing hazardous wastes. Although the regulatory program developed by EPA is chiefly concerned with the disposal of hazardous wastes, Section 3003 of RCRA directed EPA to establish certain standards for transporters and to coordinate regulatory activities with the U.S. Department of Transportation (DOT).

It is estimated that 264 million metric tons (71 billion gallons) of hazardous wastes are generated each year in the United States.[1] Ninety-six percent of these wastes are disposed of at the site where are they generated.[2] Most of the waste that is shipped offsite for disposal or treatment is transported by truck; these waste shipments are usually less than 100 miles.[3] Information on highway, rail, and water shipments of hazardous wastes is limited for two reasons. First, EPA does not compile information on waste shipments on a nationwide basis. Instead, the States are responsible for tracking the movement of hazardous wastes through the use of manifests. Only a few States have computerized databases capable of extracting this kind of information. Second, general transportation databases maintained by the Interstate Commerce Commission (ICC), DOT, the Bureau of the Census, and other organizations are not capable of distinguishing hazardous waste shipments. Data on the numbers of hazardous waste spills that occur during transport and the impacts associated with such incidents are also limited (see chapter 2).

RCRA Overview

The regulatory program established by RCRA is intended to ensure that hazardous wastes generated by industrial and commercial operations are transported and treated, stored, or disposed of in a manner that protects human health and the environment. Significantly, both interstate and intrastate activities are covered.

Under RCRA, EPA is responsible for developing regulations in four major areas: identification and listing of hazardous wastes; standards for generators, transporters, and owners and operators of treatment, storage, and disposal facilities; permit requirements for all such facilities; and a manifest system, which is used to track the movement of hazardous wastes. RCRA specifies that generator standards include requirements for recordkeeping, reporting, use of appropriate containers, container labeling, providing information on the chemical composition of wastes, and complying with the manifest system. Standards for transporters must include recordkeeping and labeling requirements. Transporters also must comply with the manifest system, and restrict the transportation of hazardous wastes to permitted facilities.

States are authorized to administer and enforce a hazardous waste program in lieu of the Federal Government if their programs are at least as stringent as the Federal requirements and are consistent with the Federal program and other State programs.[4] EPA regulations specify two ways in which a State program would be considered inconsistent: if a program unreasonably restricts, impedes, or operates as a ban on the free movement of hazardous wastes across State borders; or if a State law or program has no basis in human health or environmental protection and acts as a prohibition on the treatment, storage, or disposal of hazardous wastes.[5] It should be noted that the HMTA allows DOT to preempt inconsistent State and local requirements.[6]

EPA estimates that in 1981 over 14,000 generators produced hazardous wastes and that there were 12,367 transporters of hazardous wastes.[7] The number of generators covered by RCRA has recently increased by more than 100,000 because a 1984 legislative amendment extended the scope of the law to small-quantity generators of hazardous wastes (those generating 100 kg to 1,000 kg per month). As most small-quantity generators will be shipping their wastes to offsite facilities, the number of shipments is also expected to increase.[8]

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[1] Westat, Inc., *National Survey of Hazardous Waste Generators and Treatment: Storage and Disposal Facilities Regulated Under RCRA in 1981* (Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste, 1984). Estimate covers only 1981 "regulated" wastes.

[2] Ibid.

[3] ICF, Inc., *Assessing the Releases and Costs Associated With Truck Transport of Hazardous Wastes* (Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste, January 1984), pp. 2 and 16.

[4] 40 CFR 271 contains the requirements for authorization of a State Resource Conservation and Recovery Act program.

[5] 40 CFR 271.4.

[6] The U.S. Department of Transportation (DOT) has included a special provision in its hazardous wastes regulations noting that any State or local requirement is inconsistent if it applies only to waste materials and applies differently from or in addition to the DOT requirements. See 49 CFR 171.3(c). As described later in this appendix, DOT exercised its preemption authority when it required the use of a uniform manifest. Ch. 4 contains additional information on preemption under the Hazardous Materials Transportation Act.

[7] This is the most recent data available. See Westat, Inc., op. cit.

[8] The U.S. Environmental Protection Agency recently published final rules for small-quantity generators. Transporter requirements are explicitly addressed. See 51 F.R. 10146, Mar. 4, 1986. The regulations become effective in September 1986.

DOT and EPA Coordination

RCRA explicitly states that regulations promulgated by EPA for transporters be consistent with DOT regulations established under the HMTA, and authorizes EPA to make recommendations to DOT regarding the regulation of hazardous wastes and the addition of materials covered by the HMTA. In February 1980, EPA promulgated final regulations for transporters of hazardous wastes and adopted DOT regulations for labeling, marking, placarding, using proper containers, and reporting discharges. DOT amended its hazardous materials regulations in May 1980, to make them applicable to hazardous wastes and to incorporate additional requirements for the transportation of hazardous wastes. In 1984, a uniform hazardous wastes manifest, jointly developed by DOT and EPA, was published. To coordinate the activities of DOT and EPA, a Memorandum of Understanding (MOU) was signed in 1980. The MOU delineates the responsibilities of each agency with respect to investigations, enforcement, and information exchange. EPA enforcement activities and training under RCRA are discussed in chapter 5.

Shippers and Carriers Subject to RCRA Regulation

DOT considers a shipper to be any entity that performs any of the functions in 49 CFR 172 and 173, such as labeling or packaging. EPA calls a person or firm fitting DOT's description of a shipper a waste "generator." A generator is defined as, "any person, by site, whose act or process produces hazardous waste . . . or whose act first causes a hazardous waste to become subject to regulation."[9]

EPA's definition of a generator includes any person who removes hazardous waste sludges and any residues in transport vehicles or vessels that have carried products or raw materials.[10] If a person other than the owner of the transport vehicle or vessel is hired to remove and dispose of sludges and residues, or a vehicle or vessel is taken to a central facility for cleaning, EPA believes that all parties are generators and can be held jointly and severally liable if the regulations are violated.[11]

Carriers are defined by DOT as persons engaged in the transportation of passengers or property by land or water, as a common, contract, or private carrier, or civil aircraft.[12] EPA refers to carriers as "transporters" and defines transporters as persons, "engaged in the *offsite* transportation of hazardous waste by air, rail, highway, or water."[13] EPA regulations do not apply to onsite shipments of hazardous wastes by generators or owners/operators of permitted facilities.

Under special circumstances, transporters can become generators of hazardous wastes: by importing hazardous wastes into the United States,[14] by mixing hazardous wastes of different DOT shipping descriptions by placing them into a single container,[15] or by being responsible for cleanup of a discharge of hazardous wastes or commercial chemical product that occurred during transport. In the latter case, the transporter may become a generator of the discharged material and any resulting debris, such as contaminated soil or water.[16]

If a generator or transporter accumulates hazardous wastes for more than 90 days, a RCRA storage facility permit must be obtained.[17] However, if a transport vehicle, vessel, tank, or container is used only for neutralizing wastes because they are corrosives, a facility permit is not required.[18] In addition, transfer facilities that store manifested shipments of hazardous wastes for 10 days or less are not required to obtain a facility permit.[19]

Generator Requirements

Generators of hazardous wastes are responsible for complying with the regulations established by DOT for all hazardous materials as well as additional regulations promulgated by both EPA and DOT. The regulations can be divided into four major categories: identification and notification; preparation of wastes for transport; compliance with manifest requirements; and recordkeeping and reporting. Table A-1 summarizes these requirements, indicates the responsible agency, and provides a reference to the Federal Code of Regulations.

EPA Identification and Notification

Generators begin the regulatory process by determining whether their wastes are hazardous according to EPA's criteria. A waste is considered to be hazardous if it satisfies the following conditions:

- it is a solid waste as defined by EPA;

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[9] See 40 CFR 260.10.

[10] A transport vehicle is defined as a motor vehicle or railcar used for the transportation of cargo by any mode. Each cargo-carrying body is a separate transport vehicle (e.g., each freight car). A vessel includes every description of watercraft, used or capable of being used as a means of transportation on the water. 40 CFR 260.10.

[11] 40 CFR 261.4(c) and 45 F.R. 72024, Oct. 30, 1980. Guidance provided by the U.S. Environmental Protection Agency indicates that in cases involving more than one party, the Agency will initially look to the operator of the central facility to perform the generator duties.

[12] 49 CFR 171.8.

[13] 40 CFR 260.10.

[14] 40 CFR 263.10(c)(1).

[15] 40 CFR 263.10(c)(2).

[16] 45 F.R. 12739, Feb. 26,1980; and 40 CFR 263.31.

[17] 40 CFR 262.34.

[18] 40 CFR 260.10 and 264.1(g)(6).

[19] 40 CFR 263.12.

Table A-1.—U.S. Environmental Protection Agency (EPA) and U.S. Department of Transportation (DOT) Hazardous Waste Transportation Regulations

Requirements	Agency	Code of Federal Regulations
Generator/shipper:		
1. Determine if waste is hazardous according to EPA listing criteria	EPA	40 CFR 261 and 262.11
2. Notify EPA and obtain I.D. number; determine that transporter and designated treatment, storage or disposal facility have I.D. numbers	EPA	40 CFR 262.12
3. Identify and classify waste according to DOT Hazardous Materials Table and determine if waste is prohibited from certain modes of transport	DOT	49 CFR 172.101 (see also 49 CFR 173-177)
4. Comply with all packaging, marking, and labeling requirements	EPA DOT	40 CFR 262.32(b), 49 CFR 173, 49 CFR 172, subpart D, and 49 CFR 172, subpart E
5. Determine whether additional shipping requirements must be met for the mode of transport used	DOT	49 CFR 174-177
6. Complete a hazardous waste manifest	EPA	40 CFR 262, subpart B
7. Provide appropriate placards to transporter	DOT	49 CFR 172, subpart F
8. Comply with recordkeeping and reporting requirements	EPA	40 CFR 262, subpart D
Transporter/carrier:		
1. Notify EPA and obtain I.D. number	EPA	40 CFR 263.11
2. Verify that shipment is properly identified, packaged, marked, and labeled and is not leaking or damaged	DOT	49 CFR 174-177
3. Apply appropriate placards	DOT	49 CFR 172.506
4. Comply with all manifest requirements (e.g., sign the manifest, carry the manifest, and obtain signature from next transporter or owner/operator of designated facility)	EPA DOT	40 CFR 263.20 49 CFR 174-177
5. Comply with recordkeeping and reporting requirements	EPA	40 CFR 263.22
6. Take appropriate action (including cleanup) in the event of a discharge and comply with DOT incident reporting requirements	EPA DOT	40 CFR 263.30-31 49 CFR 171.15-17

SOURCE: U.S. Environmental Protection Agency, *Hazardous Waste Transportation Interface—Guidance Manual*, prepared for the U.S. Department of Transportation, PB82-18261 (Springfield, VA: National Technical Information Service, November 1981).

- it is listed as a hazardous waste by EPA* or it is a mixture that contains a listed waste or exhibits one of four characteristics identified by EPA—ignitability, reactivity, corrosivity, or EP** toxicity; and
- it is not explicitly excluded from regulation by statute or rulemaking.[20]

Once it is ascertained that a waste is hazardous, generators are required to notify EPA and obtain an EPA identification (I.D.) number. This is done by submitting EPA Form 8700-12 to the Agency.[21] Generators should also determine that any transporters or owners/operators of treatment, storage, or disposal facilities who will eventually handle the waste have EPA I.D. numbers.

Pretransport Preparations

Most of the requirements in this category are DOT regulations that apply to all hazardous materials. They include: identifying and classifying wastes according to the DOT Hazardous Materials Table and determining if the wastes are prohibited from certain modes of transport; complying with all packaging, marking, and labeling requirements; determining whether additional shipping requirements must be met for the mode of transport used; and providing appropriate placards to the transporter. In addition, hazardous waste transporters are also required to comply with DOT modal requirements. The following discussion focuses on particular aspects of the DOT regulations as they relate to hazardous wastes.

DOT Identification and Classification.—Identification of hazardous wastes under EPA's regulations is a separate procedure from classifying wastes under DOT's regulations. DOT considers hazardous wastes to be a subset of the hazardous materials regulated by the HMTA. Determining the proper hazard classification of hazardous wastes under DOT's system is important, because DOT hazard communication and packaging requirements correspond to these hazard classes.

First, it must be determined whether a hazardous waste is listed in the DOT Hazardous Materials Table contained in 49 CFR 172. If it is not, the characteristics of the waste must be identified, based on the DOT hazard class definitions. However, the four characteristics used by EPA to identify a waste are different from DOT's hazard classes. For example, a "reactive" waste according to EPA might be an "irritating material" or "explosive" according to DOT. A waste that EPA calls "ignitable" could be either a "flammable" or "combustible" material by DOT definitions. A proper DOT shipping name for a hazardous waste that is listed in the DOT Table or falls into a DOT hazard class would consist of the name of the hazardous material or hazard class as it is listed in the DOT Table preceded by the word "waste." In those instances where a waste is not listed by DOT and does not fall into one of DOT's hazard classes, it is considered to be a Hazardous Waste "not otherwise specified" (n.o.s.) and is classified as an ORM-E[22] by DOT.

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*The U.S. Environmental Protection Agency (EPA) lists include wastes from: specific sources; nonspecific sources; and discarded commercial chemical products, off-specification species, container residues, and spill residues thereof.

**EP = Extraction Procedure.

[20] 40 CFR 262.11 and 40 CFR 261. The 1984 amendments to the Resource Conservation and Recovery Act contain provisions regarding the listing and delisting of hazardous wastes; these provisions have not yet been fully implemented by the U.S. Environmental Protection Agency. See Sec. 222 of the Hazardous and Solid Waste Amendments of 1984, Public Law 98-616, Nov. 8, 1984 and Conference Report 98-1133, Oct. 3, 1984.

[21] 40 CFR 262.12.

All small-quantity generators of hazardous wastes—those who produce 100 kg to 1,000 kg of waste per month—must comply with the DOT regulations. Moreover, generators of hazardous wastes that are exempt from EPA regulation under RCRA because they produce less than 100 kg of waste per month may still have to comply with DOT transportation requirements; this is true only if the waste is listed in the DOT Hazardous Materials Table or fits into one of the DOT Hazard Classes other than ORM-E.

Marking, Labeling, and Placarding.—All shipments of hazardous wastes must comply with appropriate DOT marking, labeling, and placarding regulations. However, ORM-E materials are subject only to DOT marking and general packaging requirements.[23] Thus, labels and placards are not required for hazardous waste shipments classified as ORM-E.

As described in chapter 4, DOT requires shippers (generators) to mark all packages with a capacity of 110 gallons or less with a proper shipping name, including a United Nations/North American (UN/NA) identification number. There is a single UN/NA number for all hazardous wastes in the "Hazardous Waste n.o.s." category; it is NA 9189.[24] In addition, EPA requires generators to mark each hazardous waste container of 110 gallons or less with a statement identifying the generator and indicating that Federal law prohibits improper disposal of hazardous wastes.[25]

Packaging.—OTA's data analysis (see chapter 2) indicates that corrosive materials have the highest accident and spill rate. Since many hazardous wastes are corrosives, selecting a compatible container for transport is important. While DOT packaging regulations specify acceptable containers, the potential for misusing containers exists unless generators and transporters understand and comply with these requirements. With more than 100,000 small businesses becoming subject to EPA and DOT regulations, the potential for confusion and inappropriate use of containers is immense. Significantly, information sent to small generators by EPA in 1985 merely referenced DOT regulations; detailed guidance on the transportation of hazardous wastes has not been provided to small generators.[26]

In addition to the regulations for all hazardous materials, DOT has promulgated two special packaging rules that apply to hazardous wastes. The first rule allows the use of an open head drum instead of a closed head drum for wastes containing solids or semisolids.[27] The second rule allows the shipment of hazardous wastes in used packaging that has not been reconditioned or tested under specified circumstances.[28]

Manifest Requirements

The purpose of the manifest system, established by Section 3002(5) of RCRA, is to assure that hazardous wastes designated for delivery to offsite treatment, storage, or disposal facilities actually reach their destination. A "manifest" is a specific form (U.S. EPA Form 8700-22 or 8700-22A) that contains information about a hazardous waste shipment and accompanies a shipment from its point of generation to its ultimate destination. A sample manifest form is shown in figure A-1. Manifests, like DOT shipping papers, provide information about the nature of the shipment to emergency responders when accidents or incidents occur. The only significant difference between a manifest and a DOT shipping paper is that a manifest lists the EPA identification numbers of the generator, transporter, and designated facility. DOT regulations specify that an EPA manifest may be used in place of a DOT shipping paper.[29]

Generators are responsible for originating and signing the form. They must also obtain the signature of the transporter, retain one copy of the form for their records,

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[22] ORM-E means Other Regulated Material not included in any other Department of Transportation (DOT) hazard classes. Materials in this class include hazardous substances and hazardous wastes. 49 CFR 173.500 and 173.1300. See ch. 4 for additional information on DOT hazard classes.

[23] 49 CFR 173.1300; and 49 CFR 173.510.

[24] In 1978, when the U.S. Environmental Protection Agency (EPA) initially published regulations for hazardous wastes transportation, the U.S. Department of Transportation (DOT) had not yet adopted the United Nations/North America numbering system. At the time, EPA was concerned that there were no placarding requirements for hazardous materials presenting chronic (e.g., carcinogenic) hazards and indicated that recommendations to DOT regarding the development of additional placards were being considered. Following DOT's decision to adopt the U.N. numbering system, EPA stated that it was satisfied that DOT's requirements were fully protective of human health and the environment. See 45 F.R. 12741, Feb. 26, 1980.

[25] 40 CFR 262.32.

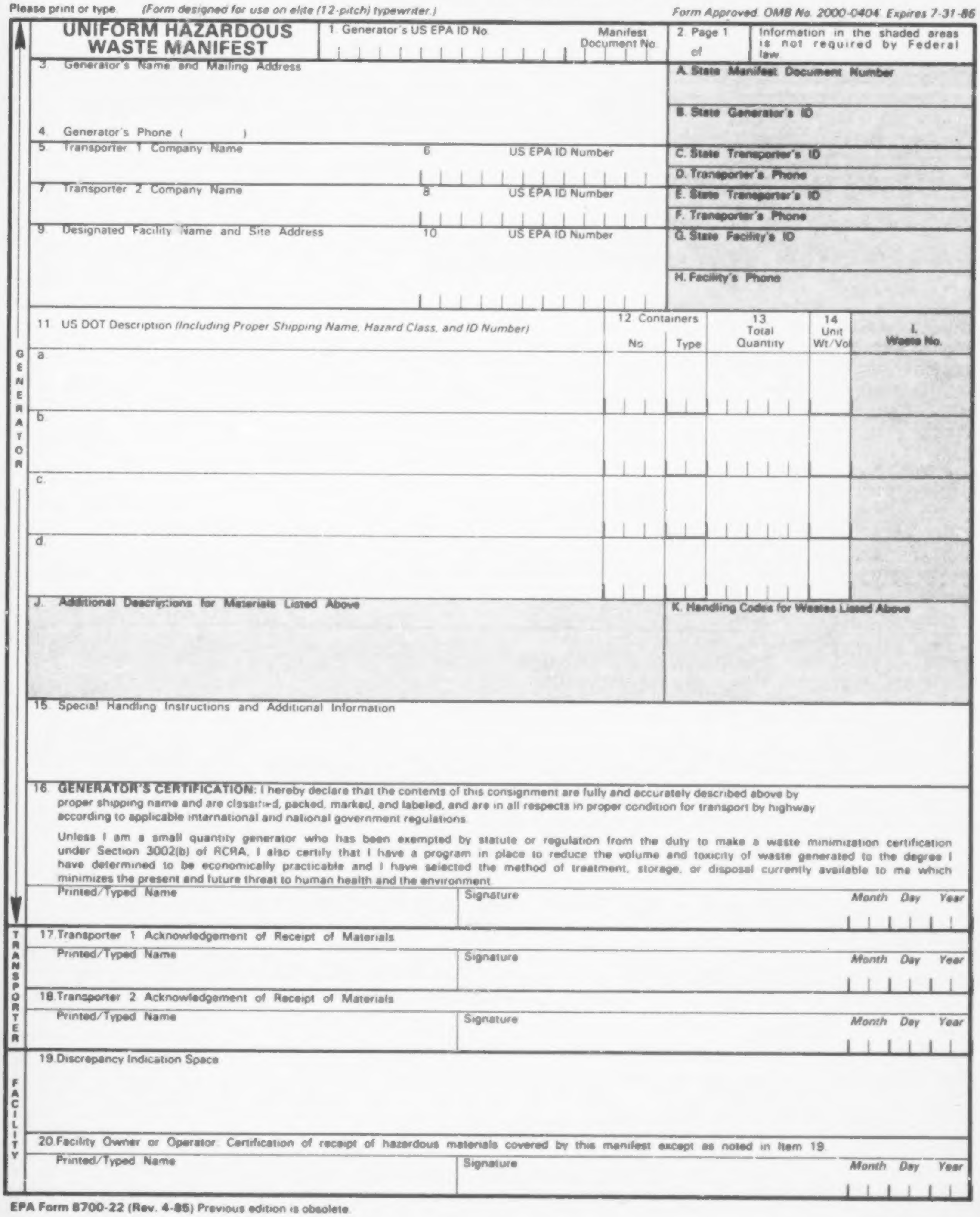
[26] The U.S. Environmental Protection Agency and the U.S. Department of Transportation published a guidance manual in 1981 about the interface between their regulations; however, an updated version has not been published to reflect changes in the regulations. See U.S. Environmental Protection Agency, *Hazardous Waste Transportation Interface—Guidance Manual*, PB82-182361, prepared for the U.S. Department of Transportation (Springfield, VA: National Technical Information Service, November 1981).

[27] 49 CFR 171.3(e).

[28] 49 CFR 173.28(p).

[29] 49 CFR 172.205.

Figure A-1.—Hazardous Waste Manifest



Please print or type. *(Form designed for use on elite (12-pitch) typewriter.)*

Form Approved. OMB No. 2000-0404. Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.

Manifest Document No.

2. Page 1 of

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address

4. Generator's Phone (   )

A. State Manifest Document Number

B. State Generator's ID

5. Transporter 1 Company Name

6. US EPA ID Number

C. State Transporter's ID

D. Transporter's Phone

7. Transporter 2 Company Name

8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address

10. US EPA ID Number

G. State Facility's ID

H. Facility's Phone

GENERATOR

11. US DOT Description *(Including Proper Shipping Name, Hazard Class, and ID Number)*	12. Containers		13. Total Quantity	14. Unit Wt/Vol	**I. Waste No.**
	No.	Type			
a.					
b.					
c.					
d.					

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

Printed/Typed Name | Signature | *Month Day Year*

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | *Month Day Year*

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | *Month Day Year*

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name | Signature | *Month Day Year*

EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete.

and give the remaining copies to the transporter. Transporter requirements under the manifest system are described below.[30]

When the initial RCRA regulations were issued in 1980, EPA required only that certain types of information accompany a waste shipment. This flexible approach was taken so that information required by EPA would also fulfill DOT's shipping paper requirements. Subsequently, more than 20 States developed their own manifest forms requiring generators and transporters to provide a variety of information. Recognizing the burden created by multiple State manifests, EPA and DOT jointly developed the uniform manifest form, that became effective on September 20, 1984. The form includes space for optional information that may be requested by a State agency. (See items A through H in figure A-1.) However, this additional information may be requested only from generators and owners or operators of treatment, storage, or disposal facilities. States may also require generators or facilities to submit this additional data under separate cover. EPA and DOT determined that it was not appropriate or necessary for transporters to submit information beyond the Federal requirements.[31]

Recordkeeping and Reporting

Generators are required by EPA to keep a copy of each signed manifest for 3 years whether or not a signed copy is returned to the generator by the designated treatment, storage, or disposal facility. Records of all test results, waste analyses, or other determinations and copies of all reports submitted to EPA (described below) must also be kept for at least 3 years. One of the reasons EPA chose a 3-year time period is that it is the same record retention time ICC requires of truckers.[32]

Biennial reports must be submitted to EPA by all generators who ship their wastes offsite.[33] The report describes all shipments initiated by the generator during a given time period. In addition, if a generator does not receive a signed copy of a manifest from the designated treatment, storage, or disposal facility within 45 days of the date the waste was accepted by the initial transporter, an Exception Report must be filed with EPA.* Exception Reports assist EPA in determining whether the waste was improperly disposed.

Transporter Requirements

Transporters of hazardous wastes are also regulated by both EPA and DOT. There are four categories of requirements: notification and pretransport, manifest requirements, recordkeeping, and discharge cleanup. Table A-1 also summarizes the regulations applicable to transporters. Some States have also developed permit and registration programs for hazardous waste transporters. (See chapter 4, especially table 4-7.)

Notification and Pretransport

All transporters of hazardous wastes are required to notify EPA and obtain an I.D. number from EPA by submitting EPA Form 8700-12. Transporters must also be sure that DOT hazard communication and packaging requirements have been met. DOT regulations prohibit transporters in all modes from accepting hazardous materials that have not been properly identified, packaged, marked, or labeled.[34] Special requirements for leaking packages or containers have been established by DOT for each transport mode.[35]

Transporters are responsible for applying appropriate placards on motor vehicles, except for highway cargo tanks and intermodal tanks. Placards must be provided to transporters by generators of hazardous wastes, unless the vehicle is already appropriately placarded.[36] In the case of railcars, highway cargo tanks, intermodal tanks, and certain freight containers, the generator is responsible for affixing the necessary placards.[37]

Manifest Requirements

EPA regulations prohibit transporters from accepting hazardous waste shipments from shippers without a manifest. Transporters who do accept manifested hazardous wastes are required to sign and date the manifest and return a signed copy of the manifest to the generator and ensure that the manifest accompanies the wastes to the designated facility. When the shipment is delivered to the designated facility or subsequent transporter, the transporter must: obtain a signature from the owner or operator of the facility or the accepting carrier upon delivery, retain one copy of the manifest, and give the remaining copies to the owner or operator of the facility or the accepting transporter.[38] A transporter is responsible for a hazardous waste shipment until the manifest is signed by the receiving facility. If a hazardous waste shipment cannot be delivered to the facility designated on the manifest, the transporter must contact the generator for further instructions.[39] Special manifest requirements for bulk shipments by water and rail have been established.[40]

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[30] 40 CFR 262, Subpart B.

[31] See 49 F.R. 10490 and 49 F.R. 10507, Mar. 20, 1984, for a discussion regarding the development of the uniform manifest.

[32] 45 F.R. 12742, Feb. 26, 1980, and 40 CFR 262.40. Retention times for records can be extended by the U.S. Environmental Protection Agency for enforcement or other purposes.

[33] 40 CFR 262.41. Use of the U.S. Environmental Protection Agency Form 8700-13A is required.

*Within 35 days, a generator must contact the designated facility to determine the status of the wastes.

[34] 49 CFR 174.3, 175.3, 176.3, and 177.801.

[35] 49 CFR 174, 175, 176, and 177.

[36] 49 CFR 172.506.

[37] 49 CFR 172.508, 172.512, and 172.514.

[38] 40 CFR 263.20.

Recordkeeping Requirements

Transporters must also keep a copy of each signed manifest for 3 years; this includes shipping papers that may be used in place of manifests for bulk shipments.[41] For shipments of hazardous wastes outside of the United States, transporters are also required to retain copies of the manifests for a 3-year period.[42]

Discharges and Cleanup

In the event of a discharge of hazardous waste during transport, special requirements established by EPA and DOT must be followed. A discharge of hazardous waste is defined as: "the accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous waste into or on any land or water."[43]

EPA regulations require all transporters to take appropriate immediate action in the event of a discharge. Such action could include notifying local authorities or diking an area to contain the wastes.[44] In addition, DOT immediate notification requirements for hazardous materials incidents are applicable to discharges of hazardous wastes; notice is given by calling (toll-free) the National Response Center, operated by the U.S. Coast Guard.[45] Additional information about DOT reporting requirements is presented in chapter 2.

Both EPA and DOT have included provisions in their regulations authorizing Federal, State, or local government officials to permit the immediate removal of hazardous wastes by transporters who do not have EPA I.D. numbers and without a manifest.[46] EPA has also exempted all persons involved with treatment or containment activities taken during an immediate response to the discharge of hazardous wastes or materials from facility permitting requirements.[47]

All regulations for the final disposition of wastes must be followed after the emergency is over. EPA has established a procedure for rapidly issuing I.D. numbers to emergency response personnel, shippers, or carriers who need to transport hazardous wastes following an unanticipated release. A provisional I.D. number may be obtained by telephoning the appropriate EPA Regional Office.[48]

EPA regulations also require transporters to clean up any discharges that occur during transport or take actions required or approved by appropriate government officials to mitigate human health or environmental hazards. DOT regulations do not contain a comparable provision for other hazardous materials.

Finally, DOT hazardous materials requirements for written incident or accident reports must be met (see chapter 2). For discharges of hazardous wastes, transporters are required to attach a copy of the manifest to the DOT reporting form and provide the following information: an estimate of the quantity of wastes removed from the scene, the name and address of the facility to which it was taken, and the manner of disposition of any unremoved wastes.[49]

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[39] 40 CFR 263.21.

[40] 40 CFR 263.20 (e) and (f).

[41] 40 CFR 263.22(a)-(c).

[42] 40 CFR 263.22(d).

[43] 40 CFR 260.10. This definition is consistent with the one used under Sec. 311 of the Clean Water Act.

[44] 40 CFR 263.30(a).

[45] 40 CFR 263.30(c)(1); and 49 CFR 171.15.

[46] 40 CFR 263.30(b); and 49 CFR 171.3(d).

[47] 40 CFR 264.1(g)(8), 265.1(c)(11), and 270.1(c)(3).

[48] 45 F.R. 85022, Dec. 24, 1980. Subsequent to issuing a number over the telephone, the standard U.S. Environmental Protection Agency (EPA) application form is mailed to the generator or transporter and must be returned to EPA within 10 days.

[49] 49 CFR 171.16(a).

Appendix B

U.S. Department of Transportation Inconsistency Rulings

Introductory Note

Part I of this appendix describes 16 inconsistency rulings and one nonpreemption determination issued by the U.S. Department of Transportation (DOT) as of May 1986. Court actions that have been brought pertaining to these cases are also noted. Each summary indicates whether the State and local requirements reviewed by DOT were found to be inconsistent or consistent with the Hazardous Materials Transportation Act (HMTA); however, the basis for each decision is not specified. Instead, Part II of this appendix, a table, summarizes the reasons underlying DOT's conclusions for each of the major requirement types considered in the inconsistency rulings.

PART I: STATE AND LOCAL REQUIREMENTS CONSIDERED IN DOT INCONSISTENCY RULINGS

Inconsistency Ruling 1
New York City

Associated Universities, Inc. (AUI), operators of Brookhaven National Laboratories located in Upton, Long Island, shipped spent fuel over a 6-week period each year prior to 1976. This practice ceased after New York City passed an ordinance which became effective on January 5, 1976, that effectively banned most commercial shipments of radioactive materials in or through the city. AUI subsequently used a water crossing from Long Island to Connecticut until local jurisdictions in Connecticut prohibited the use of their roads. The Brookhaven shipments have been suspended since that time. AUI filed an inconsistency ruling application with DOT on March 1, 1977, to determine whether the New York City restrictions were inconsistent. DOT published a decision on April 20, 1978, concluding that there was no identifiable requirement in the HMTA or associated regulations providing a basis for a finding of inconsistency (43 F.R. 16954). However, DOT announced that it intended to examine the need for Federal routing requirements. On January 19, 1981, DOT issued Federal routing requirements for high-level radioactive materials such as spent nuclear fuel, Docket HM-164; however, transportation modes alternative to the use of highways were not addressed.

New York City filed suit against DOT on March 25, 1981, challenging the validity of the Federal routing rule. The District Court opinion, issued on February 19, 1982, found that although HM-164 was procedurally within the scope of DOT's authority, it violated the HMTA and the National Environmental Policy Act (NEPA) as it did not address the problems posed by low-probability, high-consequence accidents. Moreover, the District Court held that the HMTA required DOT to compare the relative safety of different transport modes (536 F. Supp. 1237 (1982)). This decision was reversed by the U.S. Court of Appeals for the Second Circuit on August 10, 1983. The Court of Appeals ruled that DOT is not required to maximize public safety on a jurisdiction-by-jurisdiction basis; the Court also found that a comparison of different transportation modes was not required (715 F.2d 732 (1983)). The City and State of New York appealed to the Supreme Court, but the Court declined to hear the case (104 S.Ct. 1403 (1984)).

On December 24, 1984, New York City filed an amended application with DOT requesting a waiver of the preemptive effects of HM-164 on its routing restrictions for irradiated or spent fuel. Following a public comment period, DOT issued the first nonpreemption determination under the HMTA. DOT's decision, published on September 12, 1985, denied New York City's request because the City failed to show that HM-164 does not provide an adequate level of safety because of unique physical conditions, and that the establishment of alternate routes is the responsibility of a State routing agency (50 F.R. 37308). New York City filed an administrative appeal with DOT (50 F.R. 47321, November 15, 1985); public comments are currently under review.

Inconsistency Ruling 2
Rhode Island

The Division of Public Utilities and Carriers of Rhode Island issued rules and regulations governing the transportation of liquefied natural gas and liquefied petroleum gas that became effective on November 3, 1978. Shortly thereafter, National Tank Truck Carriers, Inc. (NTTC) filed suit against Rhode Island seeking preliminary and permanent injunctive relief preventing enforcement of the regulations. Rhode Island filed an inconsistency ruling application with DOT on December 1, 1978. The District Court denied NTTC's motion for a preliminary injunction except for three State requirements pertaining to vehicle equipment (two-way radio, rear bumper sign, and frangible lock requirements) pending DOT's inconsistency ruling; the preliminary injunction was upheld on appeal by the U.S. Court of Appeals for the First Circuit (608 F.2d 819 (1979)).

DOT issued its inconsistency decision on December 20, 1979, concluding that the following Rhode Island rules and regulations were consistent: radio communications via two-way radios, immediate notification of the State Police of any accident, use of headlights at all times, vehicle inspections, and definitions. However, other requirements were found to be inconsistent: written notification of State agencies regarding accidents, illuminated rear bumper signs, frangible shank-type locks on trailers, permit requirements for each shipment, and prohibitions on travel during rush hours (44 F.R. 75565).

Following publication of DOT's ruling, Rhode Island decided not to enforce the bumper sign and lock requirements, but appealed those portions of the DOT ruling on the requirements for written notification of State agencies of accidents, permit requirements, and travel prohibitions during rush hours. DOT's second decision was consistent with its earlier ruling (45 F.R. 71881, October 30, 1980).

The District Court upheld DOT's inconsistency ruling on March 17, 1982, by ordering a permanent injunction against the permit, curfew, and written accident report requirements. Regulations concerning two-way radio communication, immediate reporting of accidents, illumination of headlights, and vehicle inspections were found to be consistent with the HMTA and not in violation of the equal protection or commerce clauses of the Constitution (535 F. Supp. 509 (1982)). NTTC appealed the District Court opinion, but the U.S. Court of Appeals for the First Circuit affirmed the lower court decision (698 F.2d 559 (1983)).

Inconsistency Ruling 3
Boston

The Boston Fire Commissioner and the Commissioner of Health and Hospitals promulgated regulations on December 15, 1980, governing the transportation of hazardous materials, including restrictions on the use of city streets. On February 5, 1980, the Hazardous Materials Advisory Council (HMAC) and the Massachusetts Motor Trucking Association, Inc. (MMTA) filed an inconsistency ruling application with DOT; the American Trucking Association (ATA) subsequently filed an application. In addition, on March 2, 1980, ATA and MMTA filed suit against Boston seeking an injunction and declaratory relief from the Boston regulations. A Temporary Restraining Order against the implementation and enforcement of the regulations was granted by the Federal District Court the following day.

DOT published its inconsistency ruling on March 26, 1981 (46 F.R. 18918). The decision concluded that the following regulations were consistent: immediate reporting of accidents to local officials, requiring the use of major thoroughfares except as necessary for pickups and deliveries, assessing penalties associated with valid local regulations, requiring the use of headlights, specifying separation distances between vehicles, vehicle operating requirements, and adopting Federal and State motor carrier safety regulations. However, several Boston regulations were found to be inconsistent: marking vehicles to identify products being carried, requiring signs on vehicles when residual materials are present, requiring written accident reports, restricting travel during morning rush hours, and restricting the use of certain city streets. The routing restrictions diverted traffic onto routes passing through suburban jurisdictions. DOT did not provide rulings for several other regulations. For example, a decision about the validity of a permitting system was not provided because the scope and conditions of the permits were not defined; however, DOT noted that Boston regulations requiring transporters to carry permits in a vehicle cab and to display decals, to the extent they are valid, were reasonable aids to local enforcement.

On August 10, 1981, Boston appealed DOT's ruling on the routing restrictions and written accident reports. In response, DOT upheld its earlier decision with respect to written accident reports, but rescinded its earlier inconsistency ruling on the routing restrictions, stating that it could not reach a conclusion about the validity of those requirements. The reason for DOT's opinion was that although Boston had demonstrated that its restrictions enhanced public safety, consultation with affected jurisdictions had been limited. (47 F.R. 18457).

Following publication of the first DOT decision, HMAC, MMTA, and ATA asked the Court to issue a preliminary injunction. On April 6, 1981, the Court granted a preliminary injunction against the regulations requiring trucks to carry permits and decals and for the vehicle marking requirements; by stipulation, Boston agreed to drop these requirements. Subsequently, a trial was held to consider the routing and curfew restrictions. As of May 1986, a decision had not yet been issued by the District Court.

Inconsistency Ruling 4
State of Washington

In March 1980, the Washington State Legislature approved a law requiring intrastate shipments of hazardous materials transported by motor vehicle to be accompanied by red or red-bordered shipping papers. On July 1, 1980, NTTC filed an inconsistency ruling application. DOT's ruling, published on January 11, 1982, found the Washington State law and associated regulations to be inconsistent (47 F.R. 1231).

Inconsistency Ruling 5
New York City

On August 7, 1982, a tank truck owned by Ritter Transportation was carrying liquefied petroleum gas from New Jersey to New York across the George Washington Bridge when it developed a leak, causing an extensive traffic jam. Subsequently, New York City filed suit against Ritter in a New York State Supreme Court charging that fire department regulations, adopted in 1962 and revised in 1963 and 1979, prohibiting the transportation of hazardous compressed gases in the city without a permit, had been violated. The fire department regulations also covered placarding and container testing and specified hazard class definitions for gas under pressure, combustible or flammable gas, combustible mixture, and inflammable mixture; these requirements and definitions differed from DOT regulations and hazard class definitions. Between September and November 1980, applications for inconsistency rulings regarding the definitions were submitted to DOT by Ritter Transportation, the National LP-Gas Association, and the Propane Corp. of America; DOT consolidated the proceedings into one action.

After the New York Supreme Court preliminarily enjoined Ritter from transporting hazardous compressed gases in the city, Ritter appealed to the U.S. District Court asking that the injunction be vacated. In addition, NTTC and Ritter filed an action against the city in the same Federal court seeking a declaratory judgment that the fire department regulations burdened interstate commerce and were preempted by the HMTA. The District Court denied Ritter's motion to vacate the preliminary injunction and found the fire department routing regulations to be consistent, but ruled that the truck placarding and container testing requirements were inconsistent. The District Court did not rule on the definitions (515 F.Supp. 663).

Ritter and NTTC appealed the decision on the routing and definition regulations to the U.S. Court of Appeals for the Second Circuit. The Court of Appeals upheld the routing regulations on May 3, 1982; however, the case was remanded to the District Court for a determination as to whether the definitions were preempted under the HMTA. The Court of Appeals noted the inconsistency ruling pending before DOT (677 F.2d 270). DOT's ruling, published on November 18, 1982, determined that the definitions used by the city were inconsistent (47 F.R. 51991).

Inconsistency Ruling 6
Covington, Kentucky

General Battery Corp. submitted an application to DOT on September 25, 1980, for an inconsistency ruling on an ordinance established by the city of Covington earlier in the year requiring all commercial rail, barge, and truck operators to give advance notification of their intent to transport dangerous and hazardous substances within the city. The ordinance also defined substances covered by the notification rule; the Covington definitions extended the scope of its ordinance to materials not covered by DOT's regulations. DOT concluded that both the definitions and the notification requirements were inconsistent (48 F.R. 760, January 6, 1983).

Inconsistency Rulings 7 to 15

Inconsistency rulings 7 to 15 pertain to the transportation of spent nuclear fuel from Chalk River, Ontario, Canada, to a U.S. Department of Energy reprocessing facility at Savannah River, South Carolina. The shipments were arranged by the Nuclear Assurance Corp. (NAC) under a contract with Atomic Energy of Canada, Ltd. Until 1979, shipments from Canada entered the United States by crossing the St. Lawrence River using the Ogdensburg Bridge. These shipments were banned by both the Ogdensburg Bridge and Port Authority and St. Lawrence County in 1980. Alternative routes through Michigan, New York, and Vermont were subsequently approved by the Nuclear Regulatory Commission (NRC). However, a series of requirements and bans enacted by these States, local jurisdictions, and bridge and highway authorities resulted in the cessation of NAC shipments. NAC filed applications for inconsistency rulings on four State and local actions (inconsistency rulings 7, 8, 9, and 10) and DOT elected to examine several other State and local requirements (inconsistency rulings 11, 12, 13, 14, and 15). All nine rulings were published by DOT on November 27, 1984 (49 F.R. 46632).

Inconsistency Ruling 7
New York State

On October 8, 1982, NAC filed an application for an inconsistency ruling regarding a letter sent by a designated representative of the Governor of New York State advising NAC to suspend proposed shipments of spent fuel from Canada on two non-Interstate highway routes. The letter was sent because NAC had notified New York about its shipments, as required by NRC. NAC argued that the proposed non-Interstate routes were the only practicable highway routes available because the New York State Thruway (which is part of the Interstate Highway System) and the State of Vermont had suspended spent fuel shipments, foreclosing the use of Interstate highways through New England.

DOT concluded that the letter sent by New York State to NAC was not inconsistent because it required compliance with Federal regulations. DOT also noted that NAC properly chose to abide by the restrictions enacted by Vermont and the New York State Thruway until decisions were reached about their validity (see inconsistency ruling 9 and inconsistency ruling 10 discussions below).

Inconsistency Ruling 8
Michigan

Comprehensive rules for the transportation of radioactive materials by highway, rail, and water, issued by the Michigan State Fire Safety Board and the Department of Public Health, became effective on July 14, 1982. NAC filed an inconsistency ruling application with DOT on October 13, 1982.

DOT concluded that the following Michigan rules were consistent: confidentiality standards, inspection requirements (to the extent they apply to valid regulations), incorporation of Federal regulations, and notification of any shipment schedule changes. However, a number of regulations adopted by Michigan were determined to be inconsistent. These rules pertained to: the definition of radioactive material; submission of an application for approval of shipments; criteria for approving applications, including container testing and certification requirements that differed from Federal regulations; written notification of application approvals; communication requirements for highway, rail, and water; and notification requirements regarding delays and emergency plan implementation. Michigan has appealed the DOT ruling.

Inconsistency Ruling 9
State of Vermont

On October 14, 1982, NAC filed an application for an inconsistency ruling with DOT regarding a letter from the State of Vermont advising NAC that further highway shipments of spent fuel through the State would not be permitted until responsible Federal agencies established and enforced a uniform national policy for such shipments. Specifically, Vermont did not want to allow through shipments of spent fuel until DOT and NRC determined whether the regulations and ordinances enacted in Michigan and New York were inconsistent with the HMTA. DOT concluded that the letter could not be considered a "state order" and, therefore, the question of inconsistency did not have to be addressed.

Inconsistency Ruling 10
New York State Thruway

An inconsistency ruling application was filed by NAC on October 20, 1982, regarding a New York State Thruway Authority (NYSTA) regulation prohibiting vehicles carrying radioactive materials except under procedures adopted by the NYSTA Board. In practice, shipments of low-level radioactive materials were generally approved by NYSTA; however, shipments of highway route controlled quantities of radioactive material, such as spent nuclear fuel, were not allowed except for certain court ordered shipments. The New York State Thruway is a preferred route under HM-164 because it is part of the Interstate Highway System and alternate routes have not been designated by New York State. DOT concluded that the NYSTA prohibition was inconsistent.

Inconsistency Ruling 11
Ogdensburg-Prescott International Bridge, New York

The Ogdensburg Bridge and Port Authority (OBPA) adopted rules governing the transportation of all radioactive materials. The rules specified crossing times, required an escort and compensation for the costs of the escort, required evidence of proper insurance coverage or indemnification (but did not quantify such coverage), and incorporated St. Lawrence County's requirements (see inconsistency ruling 12). Unlike the New York State Thruway, the Ogdensburg-Prescott Bridge is not part of the Interstate Highway System. Thus, shipments of highway route controlled quantities of radioactive material over the bridge are in violation of Federal routing regulations.

On May 12, 1983, DOT initiated inconsistency ruling proceedings on the premise that New York State could designate the Ogdensburg-Prescott Bridge and associated roads in St. Lawrence County as alternate preferred routes at some point in the future. During the public comment period, the New York State Department of Law urged DOT not to consider this hypothetical case. Other comments received by DOT pointed out that OBPA regulations covered all radioactive materials, not just spent nuclear fuel. Responding to these comments, DOT narrowed its review to the requirements imposed on the transportation of radioactive materials other than highway route controlled quantities and concluded that they were inconsistent.

Inconsistency Ruling 12
St. Lawrence County, New York

St. Lawrence County, New York, located at the foot of the Ogdensburg-Prescott Bridge, adopted a law on August 11, 1980, for the highway transportation of radioactive materials. Routes through St. Lawrence County, like the Ogdensburg-Prescott International Bridge, are not part of the Interstate Highway System.

DOT initiated inconsistency ruling proceedings for these requirements along with the OBPA rules; the scope of this ruling was also limited to radioactive materials other than highway route controlled quantities for the reasons noted in the discussion of inconsistency ruling 11.

DOT determined that a section of the law which set forth the policy statement was consistent as it posed no obligation to act and did not suggest a regulatory role for the county that conflicted with the HMTA. However, DOT found that permit requirements for certain types of radioactive materials and definitions of hazard classes that differed from Federal classifications were inconsistent.

Inconsistency Ruling 13
Thousand Islands Bridge, New York

The Thousand Islands Bridge Authority (TIBA) issued regulations governing the shipment of hazardous materials, including radioactive materials. The bridge connects Collins Landing, New York, and Ivy Lea, Ontario, and is part of the Interstate Highway System; thus, it is a preferred route for the highway transport of route controlled quantities of radioactive materials.

On March 22, 1982, TIBA applied to DOT for a nonpreemption determination without acknowledging the inconsistency of its requirements, despite a direct request from DOT; DOT suspended action on the request. On May 12, 1983, DOT initiated inconsistency ruling proceedings but limited its review to the effect of TIBA permit, fee, and escort requirements on vehicles carrying highway route controlled quantities of radioactive materials. According to TIBA regulations, permits were to be issued by TIBA employees in charge at the bridge; a special escort and payment of fees could be required as a permit condition. DOT found these regulations to be inconsistent with the HMTA.

Inconsistency Ruling 14
Jefferson County, New York

Jefferson County, New York, located at the foot of the Thousand Islands Bridge, enacted a local ordinance governing highway transportation of radioactive materials. The county requirements included 24-hour prenotification, required front and rear escorts, limited transport to the period between May and October, and prohibited shipments on holidays and during inclement weather. The county also required recognition of and adherence to the permit system established by TIBA. Jefferson County contains an Interstate highway that is a preferred route for highway transport of route controlled quantities of radioactive materials.

DOT initiated inconsistency ruling proceedings on May 12, 1983, because of the connection between the Jefferson County ordinance and the requirements imposed by TIBA. DOT interpreted the types of shipments covered by the ordinance to be highway route controlled quantities of radioactive materials. Except for the escort requirement, DOT concluded that the regulations established by the county were inconsistent with the HMTA; the escort requirements were identical to NRC standards.

Inconsistency Ruling 15
State of Vermont

The Vermont Agency of Transportation adopted comprehensive rules governing highway, rail, and water transportation of irradiated reactor fuel and nuclear waste; these rules were enacted during the comment period for DOT inconsistency rulings 7 through 14. On August 4, 1983, DOT provided notice that it was initiating inconsistency ruling proceedings on the new Vermont rules as they were directly relevant to ongoing proceedings.

DOT concluded that the following rules were consistent with the HMTA: the statement of intent included in the rules, information required as part of an application for approval of shipments that were identical to NRC requirements, confidentiality standards that were the same as Federal standards; and inspection requirements to the extent that they applied to consistent rules.

However, a number of requirements were determined to be inconsistent: application of the rules to a subset of highway route controlled quantity radioactive materials; submission of applications for approval of shipments (the permit application included indemnification, fee, and container certification requirements); criteria for approving applications, written notification of application approval by Vermont; notification requirements for schedule changes and delays; and monitoring of shipments by State officials such as State Police officers. Vermont has appealed the DOT ruling.

Inconsistency Ruling 16
Tucson, Arizona

Initially, a request for an inconsistency ruling on Tucson requirements for highway shipments of radioactive materials was submitted by the Arizona Corporation Commission on February 18, 1982. However, shortly after the application was filed, responsibility for hazardous materials transportation was transferred to the Arizona Department of Transportation. On March 25, 1983, a new inconsistency ruling request was submitted by the Arizona Department of Transportation. The city requirements in question, which DOT found to be inconsistent, established definitions for radioactive materials that differed from Federal ones, prohibited the transportation of certain materials within or through the city, and required prenotification (50 F.R. 20871, May 20, 1985).

PART II: SUMMARY OF U.S. DEPARTMENT OF TRANSPORTATION (DOT) INCONSISTENCY RULING DECISIONS

Inconsistency rulings	Decisions by requirement type
	Definitions:
2, 3, 5, 6, 8, 12, 15, and 16	Definitions that differed from Federal regulations (by changing the scope of materials subject to regulation or reclassifying materials) were found to be inconsistent. The basis for these decisions was that multiple definitions presented an obstacle to uniformity of hazardous materials regulations and would reduce compliance with Federal regulations. This could have a detrimental effect on emergency response capabilities resulting in a decrease in public safety.
	Permits and prenotification:[a]
2, 3, 6, 8, 10, 11, 12, 13, 14, 15, and 16	In the decisions issued thus far, DOT has stated that permit and notification requirements as such are not inconsistent; it is necessary to look at what is required (for example, the type of information that must be submitted) to determine whether a permit or notification requirement is valid. With respect to hazardous materials generally, DOT has found requirements to be inconsistent if they cause delays or divert traffic onto routes not normally used by commercial vehicles. Moreover, if information required by a State, locality, or facility differed from what is required on DOT shipping papers, the permit or notification requirement was also found to be inconsistent. In one case, although DOT did not address the validity of the permit system, regulations requiring transporters to carry permits in a vehicle cab and display decals were found to be reasonable aids to local enforcement. For high-level radioactive materials, DOT has ruled that requirements which diverted or delayed traffic did not provide for an equitable distribution of risk and were therefore inconsistent with the routing system established under HM-164. Again, if information was required that differed from NRC and DOT shipping paper regulations, the permit or notification requirement was found to be inconsistent.
	Routing restrictions:
1, 2, 3, 10, 11, 14, and 16	Generally, local routing regulations that increase safety and are enacted by a locality in consultation with neighboring jurisdictions are considered to be consistent requirements. In those cases where transport was banned or prohibited without a permit or some type of special approval, the State, local, or facility requirements were found to be inconsistent. Such prohibitions resulted in traffic diversions and increased transit times. Restrictions affecting service to points of origin or destination within a city were found to be consistent. However, requirements pertaining to time restrictions (for example, no transport during rush hours), weather restrictions, and restrictions on the use of certain roads or streets were found to be inconsistent if they resulted in delays or diverted shipments. For high-level radioactive materials, routing regulations enacted by jurisdictions that were not designated State routing agencies under HM-164 were also found to be inconsistent.
	Accident notification:
2 and 3	Requirements for the immediate notification of local authorities in case of accidents were found to be consistent as there were no Federal regulations providing a basis for inconsistency. However, if written accident reports were required that differed from Federal reporting requirements, they were found to be inconsistent. DOT noted that it was not appropriate to impose additional written reporting requirements on carriers already subject to Federal regulation as information submitted to DOT was publicly available and the written reports were not required for emergency response purposes.
	Operational requirements:
2 and 3	Requirements pertaining to the use of headlights, separation distances, attendance, and parking were found to be consistent because DOT considered them to be proper forms of State and local regulation and there was no direct conflict with existing Federal regulations.
	Communication equipment:
2 and 8	Requirements that conflicted with existing Federal regulations were found to be inconsistent. Where there were no Federal regulations providing a basis for inconsistency, the requirements were upheld.

	Inspection and enforcement:
2, 3, 8, and 12	Inspection requirements, to the extent that they were used to enforce consistent requirements, were considered to be valid exercises of State or local police power and, therefore, consistent. Compliance with such requirements was possible without violating Federal law or regulations. DOT also ruled that penalty requirements that differed from Federal ones, were not inconsistent unless they were so extreme or applied so arbitrarily that they diverted or delayed hazardous materials shipments.
	Escorts and monitoring:
11, 13, 14, and 15	In three cases, permit systems, including escort provisions, were found to be inconsistent. In another case, monitoring of certain radioactive shipments by State Police officers was required. DOT found that to the extent an obligation to act was imposed on transporters, causing delays, the requirements were inconsistent.
	Vehicle placarding:
2 and 3	Vehicle placarding requirements that differed from Federal regulations were found to be inconsistent. DOT argued that State and local placards diverted attention from Federal ones and could have a detrimental effect on emergency response, and, ultimately, public safety. In one case, compliance with both Federal and State regulations was impossible.
	Container systems:
2, 8, and 15	Container certification requirements that were identical to Federal requirements, such as NRC regulations, were found to be consistent. Where State container design, testing, or certification requirements differed from Federal ones, they were found to be inconsistent. It is DOT's position that establishing such requirements is an exclusive Federal role and uniform standards are necessary to ensure safe and efficient transport of hazardous materials.
	Shipping papers:
4	Shipping paper requirements that differed from Federal regulations were found to be inconsistent. The reason for this was that multiple shipping papers could have a detrimental effect on emergency response and, ultimately, public safety. In addition, DOT ruled that multiple requirements obstructed the national regulatory scheme.
	Fees:
15	In one State, a fee of $1,000 per shipment of certain radioactive materials was imposed to fund a monitoring (response) team. The requirement was found to be inconsistent because it was applied in a discriminatory manner (only radioactive substances), replicated Federal emergency response efforts, and diverted shipments. DOT also asserted that approval of such a requirement would encourage other States to take similar actions and undermine HM-164.
	Indemnification:[b]
11, 13, 14, and 15	For high-level radioactive materials, indemnification requirements that exceeded those in the Federal regulations were found to be inconsistent. The reason for this was that the requirements could result in diversions of shipments causing inequitable distributions of risk and were therefore inconsistent with the routing system established by HM-164.

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[a] In most cases, prenotification requirements were incorporated into permit or registration requirements.

[b] In these inconsistency rulings, indemnification requirements were part of permit application requirements.

SOURCE: Office of Technology Assessment, based on U.S. Department of Transportation inconsistency rulings.

Appendix C

Emergency Response Planning

Emergency response plans, if properly implemented, can help organize and coordinate the response activities of a variety of agencies. Communities concerned about hazardous materials transportation accidents are developing emergency response plans that utilize community resources. Although concerns about hazardous materials truck movements usually dominate State and local planning and training, well-prepared State and local emergency response plans will address hazardous materials transportation by all relevant transport modes.

Federal Assistance

At the Federal level, the Federal Emergency Management Agency (FEMA) is responsible for administering programs that support State and local emergency response activities.[1] However, since the formation of FEMA in 1979, its emergency response programs have been focused on civil defense, radiological concerns, and natural disaster planning. Despite the overwhelming evidence pointing to the need for hazardous materials response planning and training, expansion of FEMA programs to cover hazardous materials emergencies has been limited.

Through FEMA's Emergency Management Assistance Program, States receive financial support under Comprehensive Cooperative Agreements for planning, training, and response activities; localities are funded by State emergency management agencies.[2] However, local agencies must meet extensive requirements, including the preparation of an integrated emergency operations plan that addresses all hazards, not just those involving hazardous materials, and completion of a Hazardous Identification Capability Assessment and Multi-Year Development Plan (HICA-MYDP). According to State and local officials, the HICA-MYDP document is detailed and requires numerous man-hours to complete for very limited funding that is directed essentially at civil defense preparedness.[3] To support State and local planning activities, FEMA has published several guidance documents in addition to the HICA-MYDP.[4]

The Environmental Protection Agency (EPA), FEMA, the U.S. Department of Transportation (DOT), and other Federal agencies have recently begun to work together to implement new emergency response planning initiatives and improve interagency coordination. In 1985, EPA undertook a new effort—the Chemical Emergency Preparedness Program (CEPP)—to help States and communities develop emergency response plans. While this program focuses on accidental releases from fixed facilities as part of EPA's National Strategy for Toxic Air Pollutants, the emergency response personnel and other local officials that participate in CEPP are likely to have responsibilities related to transportation accidents as well.[5] FEMA regional offices are cooperating with their EPA counterparts to support State and local CEPP efforts. CEPP is currently a voluntary program, and financial assistance for participating communities is not available, a major drawback for its implementation in many locations. However, major revisions to the Comprehensive Environmental Response, Compensation, and Liability Act under consideration by Congress are likely to affect emergency response planning and coordination at the State and local levels.

FEMA, DOT, and other Federal agencies are also revising their hazardous materials planning guide for State and local officials, FEMA-10, to reflect new technologies, regulatory requirements, and private sector initiatives; it will be issued as a joint Federal guidance document.[6]

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[1] In 1979, Federal emergency preparedness activities were consolidated into one agency—the Federal Emergency Management Agency (FEMA). Functions vested in the U.S. Departments of Commerce, Housing and Urban Development, and Defense, and the Executive Office of the President were transferred to FEMA under Reorganization Plan No. 3. See 43 F.R. 41943, Sept. 19, 1978.

[2] States must apply to the Federal Emergency Management Agency (FEMA) for financial assistance for the Emergency Management Assistance Program and other FEMA assistance programs. Comprehensive Cooperative Agreements (CCAs) are negotiated program and funding agreements between FEMA and States that identify responsibilities for meeting national program objectives. As part of the CCA process, States must submit staffing, budget, and administrative planning information, as well as statements of work for its own program and for local (subgrantee) programs. An emergency management training plan must also be developed by each State. These requirements are specified in a special civil preparedness guidance document, Federal Emergency Management Agency, *Hazard Identification, Capability Assessment, and Multi-Year Development Plan for Local Governments*, CPG 1-35 (Washington, DC: January 1985).

[3] U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—Workshop on State and Local Activities," May 30, 1985; Buddy DeWar, Director of the State Fire Marshal's Office, Tallahassee, FL, and Chief Don Ryan, Hazardous Materials Bureau, Division of State Fire Marshals, Reynoldsburg, OH, personal communications, March 1986.

[4] See Federal Emergency Management Agency, *Planning Guide and Checklist for Developing Hazardous Materials Contingency Plans*, FEMA-10 (Washington, DC: July 1981); Federal Emergency Management Agency, *Interim Guide for Development of State and Local Emergency Operations Plans*, CPG 1-8 (Washington, DC: October 1985); and Federal Emergency Management Agency, *Interim Guide for Review of State and Local Emergency Operations Plans*, CPG 1-8A (Washington, DC: October 1985).

[5] A guidance document was issued in November 1985 containing basic information on community organization, data gathering, and contingency planning, and a list of almost 400 acutely toxic chemicals. The chemical list is intended to serve as a starting point for community investigations; however, as it is based on animal toxicity data, the list does not necessarily represent hazards posed from a transportation perspective such as explosive or combustible materials. The U.S. Environmental Protection Agency directed those communities interested in other hazardous materials to consult the U.S. Department of Transportation's list of hazardous materials and hazard classes. See U.S. Environmental Protection Agency, *Chemical Emergency Preparedness Program Interim Guidance: Revision 1*, 9223.0-1A (Washington, DC: November 1985).

[6] See Federal Emergency Management Agency, *Planning Guide and Checklist for Developing Hazardous Materials Contingency Plans*, op. cit.

State and Local Emergency Response Planning

As identified by State and local governments, the primary areas needing attention during planning include:

- improved coordination among Federal, State, and local agencies;
- coordination with industry response programs;
- advance agreement about who is in charge;
- adequate communication between the accident site and offsite command posts;
- other operational concerns; and
- public information.

Better coordination in the following areas would ease many of the problems faced by State and local responders: funding for emergency response training and planning; information dissemination on appropriate hazardous materials emergency response procedures; and a clear delineation of Federal, State, and local hazardous materials emergency response capabilities and responsibilities.

State, regional, or local plans should outline specific responsibilities, coordinate on-site activities, and appoint a response leader to reduce the confusion at the accident site and provide a clear chain of authority for response activities and information dissemination to the media. Fire, police, and other government agencies, including emergency management and public works departments that may participate in emergency response, should be part of the planning process. Any governmental mutual aid agreements should determine the on-scene coordinator in advance. Simulations of emergency situations provide an opportunity to test these plans and discover organizational problems prior to an actual hazardous materials accident.

Industry has contributed to many local emergency response activities, but questions remain regarding emergency response on private property, such as a company facility or a railroad right-of-way. Advance arrangements between special industry response teams and existing public emergency response networks are necessary. Formal mutual aid agreements among independent industry response teams and communities are a means of achieving coordinated and comprehensive response capabilities at reduced expense. Such agreements allow neighboring communities to share equipment, fire and police department manpower, emergency medical services, and private sector resources. The Chemical Manufacturer's Association's Community Awareness and Emergency Response Program and EPA's Chemical Emergency Preparedness Program encourage industry cooperation in the development of community emergency response plans.

Communication and liability issues should also be covered during the planning process. Communication involves both hardware and organization. At the planning stage, participating response agencies should identify equipment requirements and procedures to ensure adequate communication, both on and offsite; equipment compatibility; and isolation of radio frequencies for emergency use. Liability issues are a concern for governmental entities, which may be held responsible for emergency response activities that result in damages. Carefully crafted Good Samaritan laws can relieve the burden of potential liability for qualified emergency responders who assist during a hazardous materials transportation accident.

Providing accurate reports to the press and public is another necessary part of coordinated emergency response activities. At many accidents, particularly severe ones, the media become a part of the response process and is an important public information source. Emergency response plans should include designating spokespersons skilled in giving print and electronic media interviews. The first media contact can determine how the incident is perceived by the public and can help maintain public calm and cooperation.

Appendix D

List of Acronyms and Other References

111A, etc.	—railroad container designations (DOT)
49 CFR	—transportation section of the Code of Federal Regulations
49-series	—series of STCCs specifically for hazardous materials
5800.1	—see F5800.1
A&H	—Alaska and Hawaii
AAR	—Association of American Railroads
ABAG	—Association of Bay Area Governments
ACE (ACofE)	—U.S. Army Corps of Engineers
AE	—Army Corps of Engineers codes (WSCS code)
ANPRM	—Advanced Notice of Proposed Rulemaking
APA	—Administrative Procedures Act
API	—American Petroleum Institute
ASME	—American Society of Mechanical Engineers
ATA	—Air Transport Association
ATA	—American Trucking Associations, Inc.
AUI	—Associated Universities, Inc.
BEA	—Bureau of Economic Analysis (U.S. Department of Commerce)
BEA Region	—Bureau of Economic Analysis Region (U.S. Department of Commerce)
BMCS	—Bureau of Motor Carrier Safety
BPNL	—Battelle Pacific Northwest Laboratory
BWR	—boiling water reactor
CAB	—Civil Aeronautics Board
CAER	—Community Awareness and Emergency Response
CERCLA	—Comprehensive Environmental Response, Compensation, and Liability Act
CFR	—Code of Federal Regulations
CHEMTREC	—Chemical Transportation Emergency Center
CHP	—California Highway Patrol
CHRIS	—Chemical Hazards Response Information System
CMA	—Chemical Manufacturers Association
COFC/TOFC	—container on flatcar/trailer on flatcar (piggyback)
CPI	—Consumer Price Index
CTC	—Canadian Transport Commission
CTS	—Commodity Transportation Survey (U.S. Bureau of the Census)
CVCF	—Commercial Vehicle Casualty File
CVSA	—Commercial Vehicle Safety Alliance
DMV	—Division of Motor Vehicles
DOD	—U.S. Department of Defense
DOE	—U.S. Department of Energy
DOT	—U.S. Department of Transportation
DVB	—divinyl benzene
ECE	—Economic Commission for Europe
ECOSOC	—Economic and Social Council
ENC	—East North Central
EODA	—Explosive and Other Dangerous Articles Act
EPA	—U.S. Environmental Protection Agency
ESC	—East South Central
Ex Parte	—legal proceeding before the Interstate Commerce Commission
F5800.1	—reporting form for HMIR
FAA	—Federal Aviation Administration
FARS	—Fatal Accident Reporting System
FCS	—Freight Carload Statistics (ICC)
FEMA	—Federal Emergency Management Agency
FHWA	—Federal Highway Administration
FLETC	—Federal Law Enforcement Training Center
FR	—Federal Register
FRA	—Federal Railroad Administration
FRERP	—Federal Radiological Emergency Response Plan
FRP	—fiberglass reinforced plastic
FSAC	—Freight Station Accounting Code—U.S. rail network
FWPCA	—Federal Water Pollution Control Act
GAO	—U.S. General Accounting Office
GVWR	—gross vehicle weight ratings
HICA/MYDP	—Hazard Identification, Capability Assessment and Multi-Year Development Plan
HLW	—high-level waste
HMIR	—Hazardous Materials Incident Reports
HMIS	—Hazardous Materials Information Service
HMTA	—Hazardous Materials Transportation Act
HSRI	—Highway Safety Research Institute (University of Michigan)
IACP	—International Association of Chiefs of Police
IAEA	—International Atomic Energy Agency

IAFC —International Association of Fire Chiefs
IAFF —International Association of Fire Fighters
IATA —International Air Transport Association
ICAO —International Civil Aviation Organization
ICC —Interstate Commerce Commission
IDOT —Illinois Department of Transportation
IIHS —Insurance Institute for Highway Safety
IM —intermodal
IMCO —Intergovernmental Maritime Consultative Organization
IMDG —International Maritime Dangerous Goods
IMO —International Maritime Organization
LLW —low-level waste
LNG —liquefied natural gas
LPG —liquefied petroleum gas
LSA —low specific activity
LWR —light water reactor
LWT —legal weight truck
MA —Middle Atlantic
MC-301, etc. —container codes applicable to trucks (see 49 CFR)
MCCS —Motor Carrier Census Survey (Bureau of Motor Carrier Safety, FHWA)
MCSAP —Motor Carrier Safety Assistance Program
MMTA —Massachusetts Motor Trucking Association, Inc.
MOU —Memorandum of Understanding
MRS —monitored retrievable storage
MSDS —material safety data sheets
MSHA —Mine Safety and Health Administration
MTB —Materials Transportation Board
MTU —metric tons uranium
NAC —Nuclear Assurance Corp.
NAHMI —National Alliance of Hazardous Materials Instructors
NASS —National Accident Sampling System
NCP —National Contingency Plan
NE —New England
NEPA —National Environmental Policy Act
NFPA —National Fire Protection Association
NHTSA —National Highway Transportation Safety Administration
NIOSH —National Institute for Occupational Safety and Health
NMFC —National Motor Freight Classification
NMTDB —National Motor Truck Data Base
n.o.s. —not otherwise specified
NPRM —Notice of Proposed Rulemaking
NRC —National Response Center (U.S. Coast Guard)
NRC —U.S. Nuclear Regulatory Commission
NRT —National Response Team
NTSB —National Transportation Safety Board
NTTC —National Tank Truck Carriers, Inc.
NWPA —Nuclear Waste Policy Act
NYSTA —New York State Thruway Authority
OBPA —Ogdensburg Bridge and Port Authority
OHMT —Office of Hazardous Materials Transportation
OKI —Ohio-Kentucky-Indiana
ORM —Other Regulated Materials
ORNL —Oak Ridge National Laboratories
OSHA —Occupational Safety and Health Administration
OTA —Office of Technology Assessment
OWT —overweight truck
PATRAM —Packaging and Transportation of Radioactive Materials
PCB —polychlorinated biphenyls
PIRS —Pollution Incident Reporting System
PNW —Pacific Northwest
PPE —personal protective equipment
PSCOG —Puget Sound Council of Governments
psi —pounds per square inch
PSW —Pacific Southwest
PTRA —Port Terminal Rail Authority
PWR —pressurized water reactor
Piggyback —trailers or containers carried on railroad flatcars
RAMRT —Radioactive Materials Routing Report
RCRA —Resource Conservation and Recovery Act
RPI —Railway Progress Institute
RQ —reportable quantity
RRT —Regional Response Teams
RSPA —Research and Special Programs Administration
SA —South Atlantic
SHMED —State Hazardous Materials Enforcement Development program
SIC —Standard Industrial Classification
SOLAS —Safety of Life at Sea

SPCL	—Standard Point Location Code (geocodification of the U.S.)
SSRMT	—State Surveillance of Radioactive Materials Transportation
STAA	—Surface Transportation Assistance Act
STCC	—Standard Transportation Commodity Code (ICC)
Schedule A	—import commodity classification code (U.S. Customs)
Schedule E	—export commodity codes (U.S. Customs)
TAF	—Truck Accident File (BMCS)
TDG	—Transportation of Dangerous Goods Regulations
TDI	—toluene diisocyanate
TEMA	—Tennessee Emergency Management Agency
TI	—Technical Instructions
TIBA	—Thousand Islands Bridge Authority
TI&U	—see TIUS
TIUS	—Truck Inventory and Use Survey (U.S. Bureau of the Census)
TOFC/COFC	—trailer on flatcar (piggyback)/container on flatcar
TRAIN II	—railroad car location information exchange network and database
TRU	—transuranic waste
TSC	—Transportation System Center
TSCA	—Toxic Substances Control Act
TSI	—Transportation Safety Institute
TSUSA	—Tariff Schedule for United States Annotated
UFC	—Uniform Freight Classification
UMLER	—Universal Machine Language Equipment Register
UN/NA	—United Nations/North American hazardous materials code
UNK	—region unknown
UP	—Union Pacific
U.S.C.	—United States Code
USCG	—U.S. Coast Guard
UTPS	—Urban Transportation Planning System
VMF	—Vessel Master File (U.S. Army Corps of Engineers)
WCSC	—Waterborne Commerce Statistics Center (Army Corps of Engineers)
WCSC	—waterborne commodity statistical codes flow database (Army Corps of Engineers)
WMF	—Waterway Master File (U.S. Army Corps of Engineers)
WNC	—West North Central
WSAF	—Washington State Accident File
WSC	—West South Central

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